Total number of printed pages–5

53 (IE 712) CCPR

2021

(Held in 2022)

COMPUTER CONTROL OF PROCESS

Paper : IE–712

Full Marks : 100

Time : Three hours

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

Symbols have their usual significances.

*Answer **any five** questions.*

1. *(a)* Draw the block diagram of a digital control system and explain the functions of different components. 8

   (b) Explain Tustin's method for signal discretization. 12

Contd.

2. *(a)* Given that $H(s)=\frac{1}{(2s+1)(4s+1)}$ with a sample time of 0.15 sec. Determine $H(z)$ (express in the standard form) and find $H(w)$ using bilinear transformation technique. 12

(b) Explain pole-zero mapping method. 8

3. *(a)* Derive the position and velocity algorithm for PID controller. Why is velocity algorithm more preferred than position algorithm ? 7

(b) Derive the difference equation of $u(k)$ *vs.* $e(k)$ for PID controller using forward rectangular rule for integration term. Find the change in output at third sample for the following data :

$K_P = 2.5$, $T = 0.4\,sec$, reset time $= 2\,sec^{-1}$, derivative time = 6 *sec*, $e_1 = 1$, $e_2 = 2$ and $e_3 = 3$ 7

(c) Solve the difference equation

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

given that $x(k)=0$ for $k \le 0$, $u(0)=1$ and $u(k)=0$ for $k \neq 0$. 6

4. Explain, with a schematic diagram, the operation of —

(i) direct digital control system (DDCS), and

(ii) distributed control system (DCS).

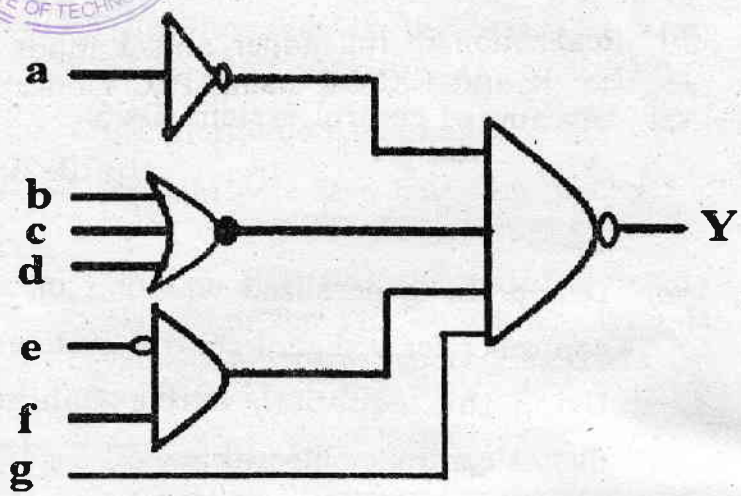
10+10=20

5. (a) Derive the generalized equation of a controller for a digital control system. Using this equation, derive Dahlin digital 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 digital controller for the system. Assume that the sampling time, T = 1 *sec.* 10

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

(b) Convert the following logic gate to PLC ladder diagram ($a-f$: Inputs, Y– Output) : 5



(c) Explain, with a diagram, the operation of a PLC timer. 5

(d) There is a timed process that occurs after a certain process count is reached. After a count of 15 from a sensor, a paint spray is to run for 25 *sec.* Write a program that accomplishes the count and the time operation. 5

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

(a) SCADA

(b) Realization of full adder and 3 input EXOR and EXNOR using PLC ladder diagram

(c) Jury's stability test