53 (IE 712) CCPR

2021

COMPUTER CONTROL OF PROCESS

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 Pole-zero mapping method for signal discretization. 10

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) Derive the position and velocity algorithms for PI-controller using trapezoidal rule for integration term. 8

3. (a) Derive the difference equation of $u(k)$ *vs* $e(k)$ for PID control using backward rectangular rule for integration term. Find the change in the output at third sample for the following data : 7

$K_p = 2.5$;

$T = 0.4\ sec$;

reset time = $2sec^{-1}$;

derivative time = $6\ sec$;

$e_1 = 1$, $e_2 = 2$ and $e_3 = 3$.

(b) If $F(z) = \dfrac{10}{(z-1)(z-0.2)}$; find $f(k)$. 6

(c) Solve the difference equation : 7

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

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

4. (a) Explain with a schematic diagram, the operation of a Distributed Control System (DCS). 10

(b) Explain with a schematic diagram, the operation of SCADA. 10

5. (a) Explain Jury's stability test. 13

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

$$P(z) = z^4 - 1.2z^3 + 0.7z^2 + 0.3z - 0.08 = 0$$

Test whether the system is stable or not. 7

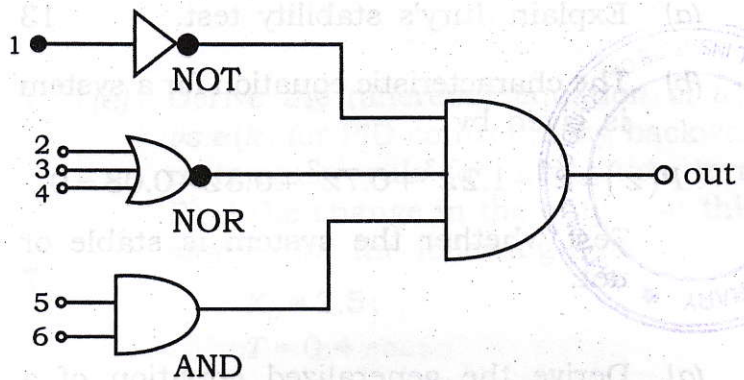
6. (a) Derive the generalized equation of a controller for a digital control system. Using this equation, derive Deadbeat digital controller algorithm. 10

(b) The open-loop transfer function of a process is given by $G(s) = \left(\frac{e^{-2s}}{10s+1} \right)$.

Design a Deadbeat digital controller for the system. Assume that the sampling time, $T = 1$ *sec.* 10

7. (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 :
[1–6 : inputs; out : output] 4



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

(d) Write a program using PLC ladder diagram for a water filling system in an overhead tank and explain. 6

8. Write short notes on : ***(any two)*** 10×2=20

(i) Direct digital control

(ii) Tustin's method

(iii) Realization of full-adder and 1 : 4 Demultiplexer using PLC ladder diagram.