53 (IE 712) CCPR

2018

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) Draw and analyze the loop structure with continuous process and digital controller. 10

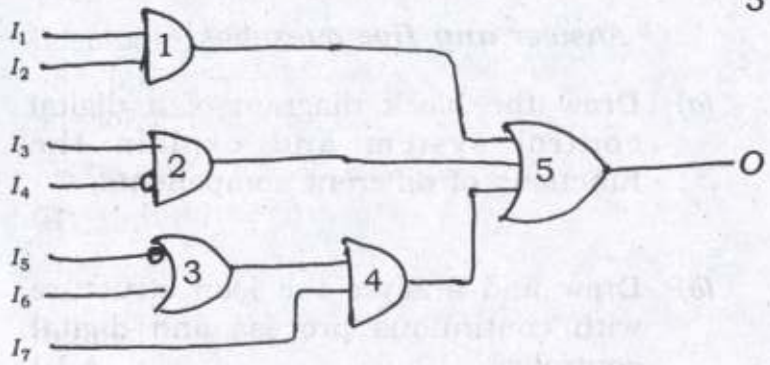
2. *(a)* Draw the block diagram of a Distributed Control System (DCS) and explain the functions of different components. 10

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

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

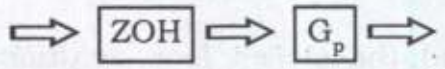
(b) What are the advantages of a PLC over relay based circuits ? 5

(c) Convert the following logic gate to PLC ladder diagram (I–Input, O–Output) 5



(d) A fan is to be controlled from three different locations. Each location containing one START and one STOP button. Write a PLC ladder diagram. 5

4. (a) For the following system, find the OLTF (Open Loop Transfer Function) in z–domain : 5



where $G_p = \frac{5}{8}$ and $ZOH = \frac{1-e^{-st}}{s}$.

(b) What are the different algorithms used for implementation of analog controllers? Derive the algorithms for PI controller using forward rectangular rule for integration. 8

(c) Derive the difference equation of $u(k)$ vs. $e(k)$ for PID Control using trapezoidal rule for integration term. Find the change in output at third sample lor the following data : $K_P = 2$, $T = 0.4 sec$, reset time = $2 sec^{-1}$, derivative time = $6 sec$, $e_1 = 1$, $e_2 = 2$ and $e_3 = 3$. 7

5. (a) State and prove Final Value Theorem (FVT) for Z–transformation. Find the final value of $f(k)$ using FVT for a given function

$$F(z) = \frac{1{\cdot}792\, z^2}{(z-1)\left(z^2 - 0{\cdot}416\, z + 0{\cdot}208\right)}. \quad 7$$

(b) Using the Z-transformation, find $X(z)$ when $x(k)=\left(\frac{1}{5}\right)^k$ for $k=0,1,2,3...$ 6

(c) Find the closed loop solution of the following difference equation :

$X(k+2)+3X(k+1)+2X(k)=0;$

Given that $X(0)=0$ and $X(1)=1$. 7

6. (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 $G_s(s)=\frac{e^{-2s}}{10s+1}$. 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

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

(a) Stability of discrete data system

(b) Tustin's method for signal discretization

(c) Jury's Stability test

(d) Realization of 4:1 multiplexer using PLC ladder diagram

(e) Direct digital control.