53 (IE 712) CCPR

2013

(December)

COMPUTER CONTROL OF PROCESS

Paper : IE 712

Full Marks : 100

Pass Marks : 30

Time : Three hours

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

Answer ***any five*** *questions.*

1. *(a)* A continuous-time plant of a sampled-data system is described by the state equation

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -4 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u$$

Determine the value of sampling period T which make the system uncontrollable. 10

(b) Determine the stability of sample-data control system having following characteristics equation

$$2z^5 + 2z^4 + 7z^3 + 10z^2 + 4z + 1 = 0 \quad 5$$

(c) A discrete-time system is described by the state equation

$$y(k+2) + 5y(k+1) + 6y(k) = u(k)$$

Determine the state model in phone variable form. 5

2. (a) Find the Z transform of the following : ***(any two)*** 8

(i) $e^{-at} \sin wt$

(ii) $\frac{a^k}{k!}$

(iii) t^2

(b) Find the inverse Z transform of the following : ***(any two)*** 8

(i) $\frac{z - 0.4}{z^2 + z + 2}$

(ii) $\frac{3z^2+2z+1}{z^2-3z+2}$

(iii) $\frac{2z}{(2z-1)^2}$

(c) Find the Z domain transfer function of the S-domain transfer function 4

(i) $\frac{a}{s^2-a^2}$

(ii) $\frac{s}{s^2+w^2}$

3. The block diagram of a sampled-data control system is shown in the drawing of *Fig. (Q. 3)*. The sampling period is $\Delta t = 1 min$.

(a) Design the digital controller $D(Z)$ so that closed-loop system exhibits a minimal prototype response to a unit step change in the load variable L.

(b) Design a digital PID controller based on the ITAE (set-point) criterion and examine its performance for a step change in the set point. 20

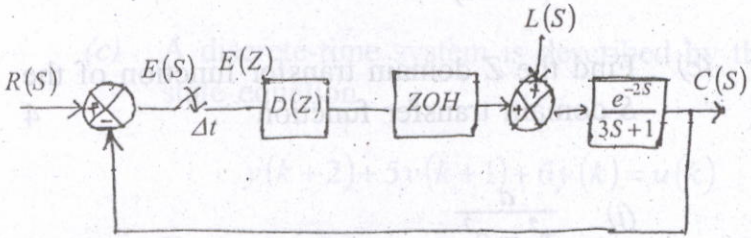

Fig. (Q. 3)

4. (a) What are the hardware and software components of SCADA System ? Discuss each of them briefly with neat sketch. 10

(b) What is data acquisition system ? Where DAS is applied ? 2+2

(c) What is the necessity of ADC in data acquisition ? Discuss briefly the operation of Successive-Approximation type ADC. 1+5

5. (a) Draw the block diagram of programmable logic controller and discuss each block briefly. 8

(b) What is ladder diagram? Draw a ladder diagram for the control problem shown in *Fig. (Q. 5b)*. The global objective is to heat a liquid to a specified temperature and keep it there with stirring for 30 min. The hardware has the following characteristics

(i) START push button is NO, STOP is NC.

(ii) NO and NC are available for the limit switches. 2+10

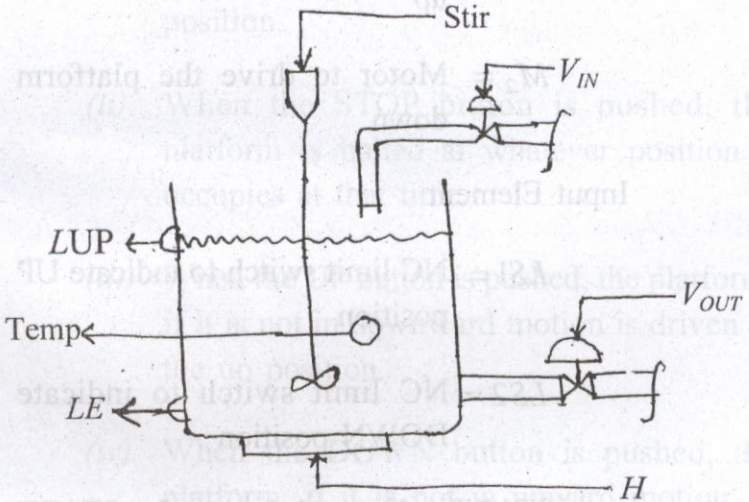

Fig. (Q. 5b)

6. The elevator shown in *Fig. (Q. 6)* employs a platform to move objects up and down. The global objective is that when the UP button is pushed, the platform carries something to the up position, and when the DOWN button is pushed, the platform carries something to the down position.

The following hardware specifications define the equipment used in the elevator :

Output Elements

M_1 = Motor to drive the platform up

M_2 = Motor to drive the platform down

Input Element

$LS1$ = NC limit switch to indicate UP position

$LS2$ = NC limit switch to indicate DOWN position

START = No push button for START

STOP = No push button for STOP

UP = No push button for UP command

DOWN = No push button for DOWN command

The following narrative description indicates the required sequence of events for the elevator system.

(i) When the START button is pushed, the platform is driven to the down position.

(ii) When the STOP button is pushed, the platform is halted at whatever position it occupies at that time.

(iii) When the UP button is pushed, the platform, if it is not in downward motion is driven to the up position.

(iv) When the DOWN button is pushed, the platform, if it is not in upward motion, is driven to the down position.

Prepare a ladder diagram to implement this control function. 20

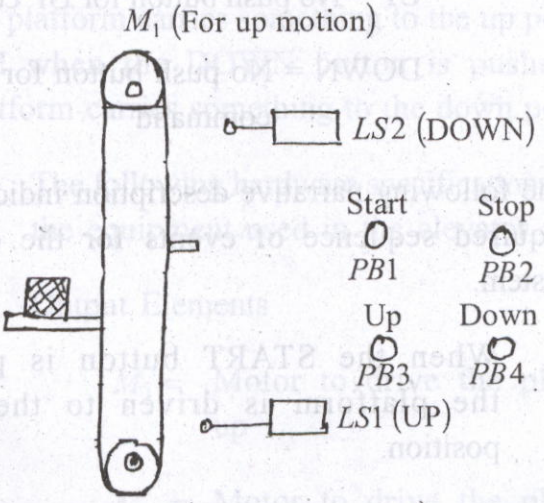

Fig. (Q. 6)

7. Write short notes on the following : ***(any four)*** 4×5

(a) Digital PID control

(b) Genetic algorithm

(c) Dahlin's algorithm

(d) PLC *vs* PC

(e) Counter operation on PLC.
