12/12.06

Ex/BESUS/CST-703/07

B.E. (CST) Part-IV 7th Semester Examination, 2007

Computer Control of Industrial Processes

(CST-703)

Time : 3 hours **Full Marks : 100**

Answer any FIVE questions.

1. A dynamical system is described in terms of the following equation : $\ddot{x} = -5\dot{x} - 6x + u(t)$. Formulate state variable representation for this system. Find the state transition matrix for this system and obtain time domain solution for a unit step input function u (t). Discretize the system with sampling time T = 1 sec. **[4+10+6]**

2. State and prove the initial value theorem and final value theorem in z-domain. Derive the transfer function of a sampler and zero-order-hold circuit in the z-domain. Obtain the z-transform of $f(t) = a \sin \omega t$. Find inverse z-transform of $F(z) = (0.6z)/(z^2 - 1.6z + 1)$. **[5+5+5+5]**

3. Describe briefly the different components of a programmable logic controller. Design a PLC based system to accomplish the following process control : Hot water is available at 60°C and it can flow past a valve at the rate of 6 *ml*/min cold water kept at 10°C can flow at a rate of 1.8 *l*/hr past another valve. 10 *ml* of water is required at a temperature of 30°C. Draw neat ladder diagram for your designed system. Compare the PLC based system with microprocessor based for the same. **[6+8+6]**

4. Explain the terms controllability and observability in connection with digital control systems. Describe the details involved in observer design. What are the limitations in observer design? An airborne vehicle is undergoing a 3-D motion. Measurement of velocity and acceleration along X and Y directions is available. Is the position along all three directions observable? Explain. **[4+4+4+8]**

5. What is bilinear transformation? Consider a system equation $Q(z) = z^3 - 1.8z^2 + 0.92z - 0.12$ and sampling time $T_S = 2$ sec. Use bilinear transformation to examine system stability. How does the analysis change when T_S is large? **[4+10+6]**

6. Formulate the estimation problem from a stochastic view point. Distinguish between filtering, prediction and smoothing. What is adaptive control? Describe the framework of algorithm design for adaptive control. **[4+6+4+6]**

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7. A digital controller has to be designed for a motor with the following system description in discrete domain :

$$x(k+1) = \begin{bmatrix} 1 & 0.095 \\ 0 & 0.905 \end{bmatrix} x(k) + \begin{bmatrix} 0.0048 \\ 0.0952 \end{bmatrix} u(k)$$

and $y(k) = [1 \quad 0]\, x(k)$.

Find the controller gains for a dead beat controller with poles at zero. Find an expression for the pole placement in terms of controller gain. How does the design change if the reconstruction of system states used for the controller input is delayed by a finite computational delay that is less than the sampling time? **[6+8+6]**

8. Write short notes on (any two) : **[10×2]**

a) PID controller design

b) pseudo-continuous control of discrete control systems

c) Choice of state variables to represent dynamical systems.

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