Inst. /SEM VIII (CBSGS) /Digital Control System/ Nov.2017

**Q. P. Code : 24123**

**( 3 Hours)** **Total Marks : 80**

**Note:** (1) **Q1** is **compulsory**.

(2) Attempt **any three** from the **remaining**.

(3) Assume suitable **data** wherever **necessary**.

Q1. Answer **any four** from the following: **(20)**

a. Map $\alpha_1 = -0.5$ and $\alpha_2 = 1$ lines from s-plane to Z-plane using impulse invariance method.

b. A first order discrete time LTI system is represented by the state model

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

$$y(k) = 0.5x(k)$$

Obtain its pulse transfer function.

c. Give the Kalman's test to find controllability and observability of a system.

d. What do you mean by state transition matrix? List its properties.

e. Explain 1-DOF (degree of freedom) and 2-DOF feedback controller.

Q2. (a) Obtain state space representation of the following systems in both first companion and second companion form. **(10)**

$$G(z) = \frac{z^3 + z^2 + z + 2}{z^4 + 0.2z^3 + 0.5z^2 + z + 5}$$

(b) A system with transfer function $G(s) = \dfrac{4}{s(s+1)}$ is sampled at instants with sampling time 0.1 sec. If the hold circuit used is of zero order, obtain the equivalent discrete data system. **(10)**

**TURN OVER**

Q3. (a) Derive the solution of the following system **(10)**

$$x(k+1) = G\,x(k) + H\,u(k)$$

$$y(k) = Cx(k) + Du(k)$$

using Z-transform method. Assuming input to a discrete system as zero but

$$x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix},\ G = \begin{bmatrix} -1 & -1 \\ -1 & 1 \end{bmatrix},\ H = \begin{bmatrix} 0 \\ 1 \end{bmatrix},\ C = [1\ \ 1] \text{ and } D = [\,0].$$

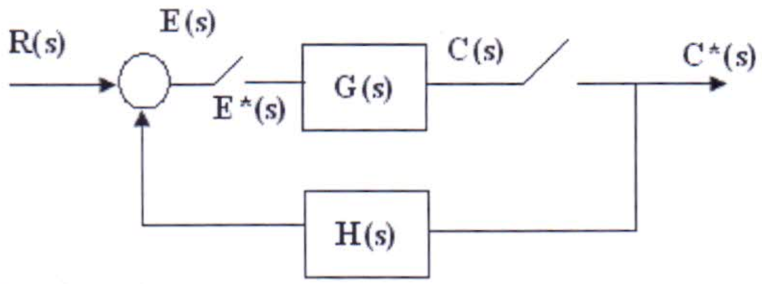
Determine x(k) for all k > 0.

(b) Given the closed loop transfer function $T(z) = N(z)/D(z)$, where,

$$D(z) = z^3 - z^2 - 0.2z + 0.1$$

Use Routh's Hurwitz criteria to find the number of z-plane poles of T(z) inside, outside and on the unit circle, Is the system stable? **(10)**

Q4 (a) Explain the Mason's gain formula to obtain transfer function from a signal flow graph. Find the pulse transfer function of the following system using sampled signal flow graph approach. **(10)**




(b) Design a state feedback controller for the system

$$x(k+1) = G\,x(k) + H\,u(k)$$

with $G = \begin{bmatrix} 1 & 0.08 \\ 0 & 0.7 \end{bmatrix}$ $H = \begin{bmatrix} 0.004 \\ 0.08 \end{bmatrix}$

for deadbeat response **(10)**

Q5. (a) Design a full order state observer so that observer poles are located at - 0.2 and - 0.4 for the system **(10)**

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

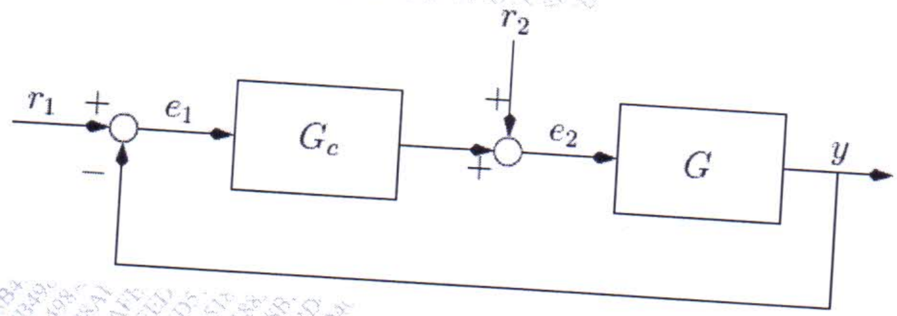
$$y(k) = [0 \quad 1]\, x(k).$$

(b) A PID controller is described by the following relation between input e(t) and output u(t): **(10)**

$$u(t) = k_p\left( e(t) + \frac{1}{T_I}\int_0^t e(t)dt + T_D\frac{de(t)}{dt}\right)$$

Using the trapezoidal rule for integration and backward-difference approximation for the derivative, obtain the difference equation model of the PID algorithm. . Also obtain the transfer function U (z)/ E (z)

Q6. (a) What do you mean by internal stability? How is it different from bounded input bounded output (BIBO) stability? For the system shown in the block diagram:




Determine the internal stability if $G = \frac{1}{z-1}$ and $G_c = \frac{1.5z-1}{z-1}$ **(10)**

(b) Define static position, velocity and acceleration error coefficient for a discrete time LTI system and find the steady state error for step, ramp and parabolic input for a unity feedback system characterized by the open loop transfer function

$$G_{ho}G(z) = \frac{0.5(z+1)}{(z-1)(z-0.5)(z-0.9)}$$

The sampling period is T=0.1 sec. **(10)**

---

BE | Sem- VIII (Rev to CBSGS) / INST / Instrument & System Design / NOV-17

Q. P. Code : 27724

( 3 Hours ) (Total Marks: 80

N. B. :
1. Q. No 1 is **compulsory**.
2. Attempt **any THREE** questions from **Q No 2 to Q No 6**.
3. **Figures** to the **right** indicate **full marks**.
4. Assume suitable **data** wherever **necessary**.

1. Solve **any Four :** (20)
   a) What is cavitation? Write its ill effects.
   b) Explain the reliability engineering terms : MTTR, MTTF and MTBF.
   c) Define control valve coefficient. Give the factors that affect this coefficient.
   d) Explain the need of thermocouple compensation, during design of Thermocouple.
   e) Define ergonomics. How ergonomics is applied in designing control panel?

2. a) Find the appropriate valve size for the following : (10)
   Fluid- Dry saturated steam, Flow rate : 63000 lb/hr, inlet pressure = 245psia,
   Outlet pressure = 215psia, pipe diameter = 6" sch 40,
   Valve is eccentric disk type Cd = 27, $X_T = 0.25$
   b) Discuss the various factors to be added while sizing of a control valve for compressible fluids flow. (10)

3. a) Find the appropriate valve size for the following : (10)
   Fluid - Water, Flow rate =1600gpm, inlet pressure = 42.6psia,
   outlet pressure = 34.7psia, Pipe diameter = 8" schedule 40 pipe,
   Specific gravity = 0.88, Type of valve is 60-degree butterfly valve with $C_d = 17$.
   b) Explain the steps to be followed for System Engineering. (10)

4. a) Write the guidelines for enclosure design. (10)
   b) Given the following data, calculate the appropriate valve size : (10)
   Fluid – Air flow $w_g = 460$ lb/hr mixed with Water flow $w_f = 20{,}000$ lb/hr, $F_f = 0.96$,
   $P_v = 0.5$ psia, $P_1 = 100$ psia, $\Delta P = 36$psi, $T_1 = 540°R$, $X_T = 0.75$, $M = 29$,
   D = 3 inch schedule 40, Valve is Globe valve with $C_d = 5$, $F_L = 0.90$,
   $V_f = 0.01607\ ft^3/lb$.

5. a) Explain the Orifice design criteria. (10)
   b) Draw a typical Control room layout diagram and explain the guidelines to design it. (10)

6. Write short note on :
   a) Control valve noise. (10)
   b) Bath tub curve and its significance in relation with Reliability. (10)

---