Total Pages—6

(Set-R_1)

B.Tech-6th

Control System Engg.

Full Marks : 70

Time : 3 hours

Answer Q. No. 1 and any five from the rest

The figures in the right-hand margin indicate marks

Symbols carry usual meaning

1. Answer the following questions : 2 × 10

   (*a*) What are the advantages of closed-loop control systems over open-loop control systems ?

   (*b*) Determine the settling time for 2% band for a system with closed-loop transfer function

   $$H(s)=\frac{9}{s^2+4s+9}.$$

   (*c*) What is the Routh's Stability criterion ?

(Turn Over)

(*d*) What is the effect of addition of a pole to the system ?

(*e*) What are the differences between PI and PD control ?

(*f*) A system is described by the transfer function

$$H(s)=\frac{1}{s^3+\alpha s^2+Ks+3}.$$

What are the constraints on α and k for the system to be stable ?

(*g*) Define the state variable of a system.

(*h*) What are the main problems associated with implementation of digital control ?

(*i*) What is the Shannon's sampling theorem ?

(*j*) State the final value theorem of the z-transform.

2. (*a*) Convert the block diagram of Fig. 1 to a signal flow-graph, and therefrom obtain the

input-output transfer function using Mason's gain rule. 5

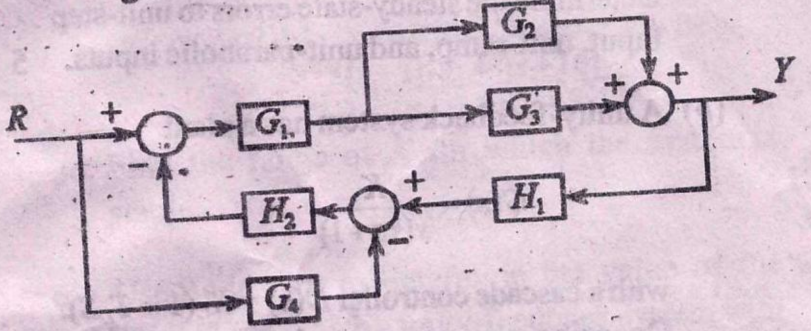

Fig. 1

(*b*) Then open-loop transfer function of a unity-feedback control system is given as

$$G(s)=\frac{K(s+1)}{s(s-1)(s^2+4s+16)}.$$

Determine the value of K which causes sustained oscillation. Also determine the corresponding frequency of oscillation. 5

3. (*a*) A unity-feedback system is characterized by the open-loop transfer function

$$G(s)=\frac{1}{s(0\cdot 5s+1)(0\cdot 2s+1)}$$

Determine the steady-state errors to unit-step input, unit-ramp, and unit-parabolic inputs. 5

(*b*) A unity-feedback system has a plant

$$G(s)=\frac{K}{s(\tau s+1)}$$

with a cascade controller $D(s)=K_C(1+T_D S)$. Describe the effects of K_C and T_D on steady-state error, settling time, and peak overshoot of the system. 5

4. Plot the root loci for a closed-loop unity feedback control system having the forward path function

$$G(s)=\frac{K(s+9)}{s(s^2+4s+11)}.$$

Locate the closed-loop poles on the root loci such that the dominant closed-loop poles have a damping ratio equal to 0·5. Determine the corresponding value of gain K. 10

5. Sketch the Nyquist plot for a feedback system with open-loop transfer function

$$G(s)H(s) = \frac{K(s+1)}{s(s-1)(s^2+4s+16)}; K > 0$$

Find the range of K for which the system is stable. 10

6. Use Bode plot to determine the value of the gain K for which a unity-feedback system with open-loop transfer function

$$G(s) = \frac{10K(s+0{\cdot}1)}{(s+2)(s+4)(s+5)}$$

gives phase margin of 50°. Also determine the gain margin at this value of K. 10

7. (*a*) Consider the system described by

$$\dddot{y} + 3\ddot{y} + 2\dot{y} = u$$

Derive a state-space representation of the system. 5

(*b*) For the transfer function models and inputs given below, find the response $y(k)$ as a function of k :

$$G(z)=\frac{Y(z)}{R(z)}=\frac{2z-3}{(z-0\cdot5)(z+0\cdot3)}$$

$$r(k)=\begin{cases}1;\ k=1\\0;\ k=0,2,3,4...\end{cases}$$ 5

8. Write short notes on any *two* of the following : 5 × 2

(*i*) Zeigler-Nichols method of tuning PID controller

(*ii*) Constant M and N circle method of stability analysis

(*iii*) Transfer function of a Zero Order Hold Device

(*iv*) Properties of the Z-transform.
