margin, and phase margin of a feedback system with open-loop transfer function

$$G(s) = \frac{25}{s(s+1)(s+10)}.$$ 10

7. (*a*) Describe the construction and working of a ac servo system. 5

(*b*) Discuss the relation between the time -domain and frequency-domain specifications for a second-order system. 5

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

(*i*) PD, PI and PID control

(*ii*) Synchros

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

(*iv*) Routh Stability Criterion.

DC, AC. $V_2 > V_1 > V_0$

$V_2 > V > V_1$

April 2016

(Set-K)

B.Tech. -6th

Control System Engineering-I

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*) Most of the industrial control schemes are based on negative feedback concept. Why ?

(*b*) What is the significance of high loop gain in feedback systems ?

(*c*) What is system-type number and what is its practical significance ?

(*d*) Define the error constant K_p, K_v and K_a.

(e) Why the derivative mode of control in a feedback system with proportional control, makes the system responseless oscillatory ?

(f) The transfer function of a first-order process is given by

$$G(s) = \frac{1}{10s+1}$$

Show the response to a step input in time domain.

(g) Define the terms : absolute stability and relative stability.

(h) What is the interpretation of stability analysis when Nyquist plot crosses the $-1+j0$ point ?

(i) Define gain margin and phase margin.

(j) What are the advantages and limitations of constant-M circles to measure the performance of a feedback system ?

2. (a) Using block diagram reduction rules, convert the block diagram of Fig. 1 to a simple

loop and obtain the closed-loop transfer function. 5

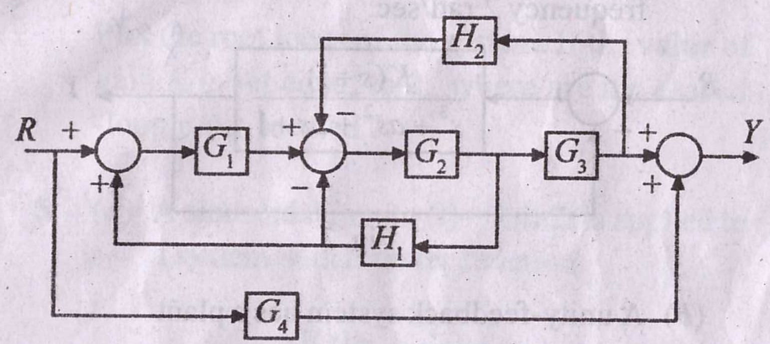

Fig. 1

(b) The signal flow graph of a system is shown in Fig.2. Determine the transfer function $\frac{C(s)}{R(s)}$ of the system using Mason's gain formula. 5

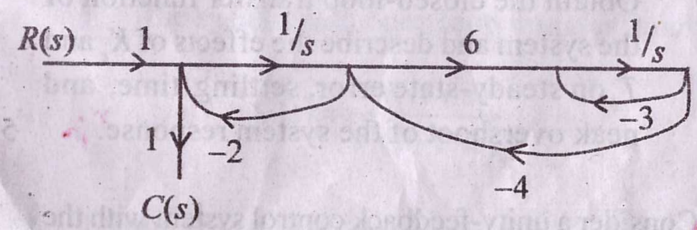

Fig.2.

3. (*a*) Determine the value of $K > 0$ and $a > 0$, so that the system shown in Fig.3 oscillate at a frequency 2 rad/sec. 5

$f = 2$

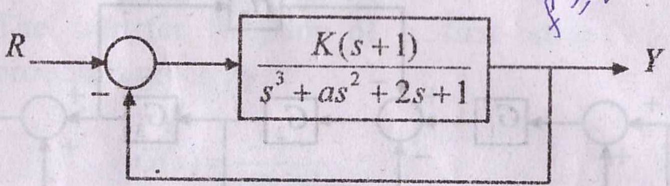

Fig. 3

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

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

with a cascaded controller $D(s) = K_c\left(1 + \frac{1}{T_I s}\right)$.

Obtain the closed-loop transfer function of the system and describe the effects of K_c and T_I on steady-state error, settling time, and peak overshoot of the system response. 5

4. Consider a unity-feedback control system with the following open-loop transfer function

$$G(s) = \frac{K}{s(s^2 + 4s + 8)}$$

Plot the root locus of the system. If the value of gain K is set equal to 2, where are the closed -loop poles located ? 10

5. (*a*) A sinusoidal input $r(t) = 2\sin 2t$ is applied to a system with transfer function

$$G(s) = \frac{2}{s(s+2)}$$

What is the steady-state value of the response $y_{ss}(t)$. 5

(*b*) Use the Nyquist criterion to determine the range of values of $K > 0$ for the stability of the system with open loop transfer function

$$G(s) = \frac{4K(1+s)}{s^2(1+0.1s)}.$$ 5

6. Using Bode plot, determine gain crossover frequency, phase crossover frequency, gain