JUNE 2008

Code: DE15 **Subject: CONTROL ENGINEERING**
Time: 3 Hours **Max. Marks: 100**

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or best alternative in the following: (2x10)

a. With feedback _____ increases.

(A) system stability **(B)** system gain
(C) system accuracy **(D)** All of the above

b. A unity feedback control system has forward path transfer function as $G(s) = \frac{s^2}{s+1}$, the type and order of system is, respectively

(A) 0, 2 **(B)** 0, 1
(C) 1, 2 **(D)** None of the above

c. The transfer function of a control system is given as $\frac{C(s)}{R(s)} = \frac{K}{s^2 + 4s + K}$. For this system to be critically damped, the value of gain K should be

(A) 1 **(B)** 2
(C) 3 **(D)** 4

d. The transfer function of a system G(s) is $= \frac{10}{s+1}$. When operated as a unity feedback system, the steady state error to a unit step input will be

(A) zero **(B)** 1/11
(C) 10 **(D)** infinity

e. Block diagram is shown in Fig.1. Find the transfer function C(s)/R(s)

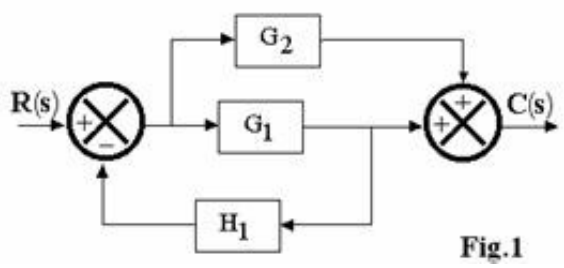

Fig.1

(A) $\frac{G_1+G_2}{1+(G_1+G_2)H_1}$ **(B)** $\frac{G_1+G_2}{1+G_1H_1}$

(C) $\frac{G_1+G_2}{1+G_2H_1}$ **(D)** $\frac{G_1\,G_2}{1+G_1G_2H_1+G_1H_1+G_2H_1}$

f. Nyquist criterion is used to find which of the following

(A) Absolute stability **(B)** Relative stability
(C) Both **(A)** and **(B)** **(D)** None of the above

g. Characteristic equation of a control system is given as

$$s^3+4s^2+8s+12=0$$

The system is

(A) STABLE **(B)** UNSTABLE
(C) MARGINALLY STABLE **(D)** DATA IS INSUFFICIENT

h. A root locus originates from _____ and terminates at _____ respectively.

(A) open loop poles, open loop zeroes
(B) closed loop poles, closed loop zeroes
(C) open loop zeroes, open loop poles
(D) closed loop zeroes, closed loop poles

i. The gain for constructing the Bode plot in relation to transfer function $G(s)H(s)=\frac{20}{s(s+2)}$ is

(A) 20 **(B)** 10
(C) 40 **(D)** 5

j. The lag-compensation has a

(A) Zero nearer to the origin **(B)** Pole nearer to the origin
(C) Pole at the origin **(D)** Zero at the origin

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. Define open loop and closed loop control system. Discuss the merits and demerits of open loop and closed loop control system. **(6)**

b. Obtain the transfer function of mechanical network shown in Fig.2.

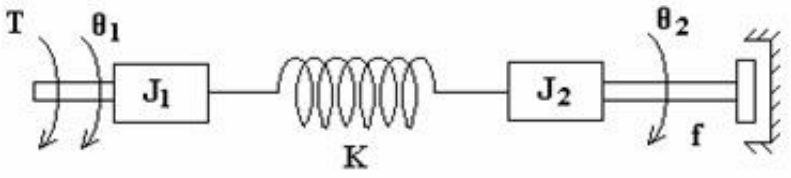

Fig. 2

where J_1 & J_2 are moment of inertia of wheel 1 & 2 respectively,

T = applied torque, K = spring constant. θ_2 must be taken as angular displacement at the output. f = coefficient of viscous friction. **(10)**

Q.3 a. An open loop transfer function for a unity feedback system is given as $G(s) = \frac{K}{s(1+sT)}$.

The above system has damping ratio as 0.2. It is desired to have a damping ratio of 0.8, determine, to what factor the amplifier gain K must be changed? **(8)**

b. Determine the transfer function for the block diagram shown in Fig.3, using block diagram reduction technique. **(8)**

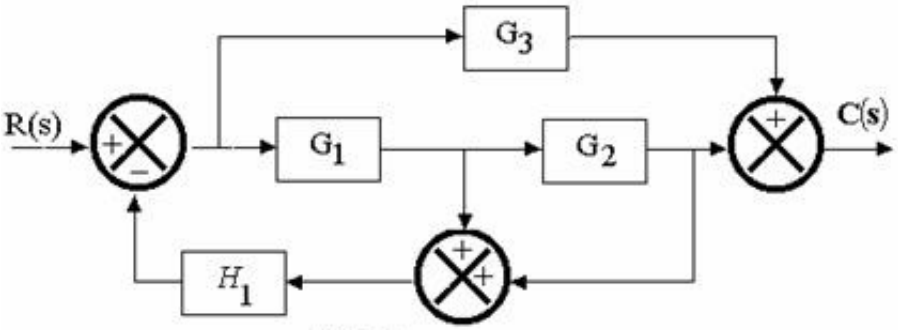

Fig. 3

Q.4 a. Obtain the transfer function for the given signal flow graph shown in Fig.4.

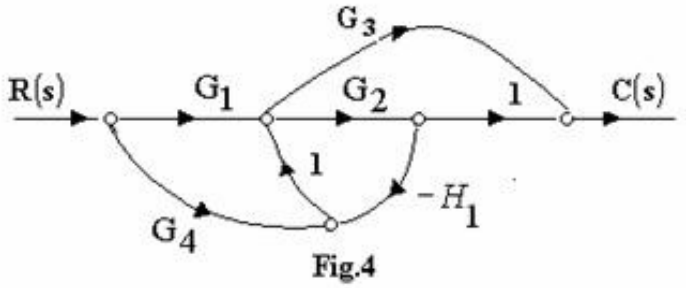

Fig.4

(8)

b. Derive the values of step, ramp and parabolic error constants and steady state error for type 1 system. **(8)**

Q.5 a. Explain with the help of block diagram important featuring. PID controllers used for controlling industrial process. **(8)**

b. Draw the root locus for the feedback system with open loop transfer function as $G(s)H(s) = \frac{K}{s(s+1)(s+2)}$. Given that K varies from 0 to ∞. **(8)**

Q.6 a. Consider the characteristic equation of a closed loop control system. Using the Routh stability criteria determine the range of 'K' so that system is stable $s^3 + 3Ks^2 + (K+2)s + 4$ **(8)**

b. Draw the bode plot for the open loop transfer function $G(s) = \frac{2000}{s(s+4)(s+10)}$. Find Gain Margin, phase margin and comment on the stability of system. **(8)**

Q.7 Draw the Nyquist plot for the given open loop transfer function $G(s)H(s) = \frac{s+2}{(s+1)(s+4)}$ comment upon the stability of system. **(16)**

Q.8 a. Draw the polar plot for open loop transfer function $G(s)H(s) = \frac{K(s+2)}{s^2(s+1)}$. **(8)**

b. Give brief notes on
(i) Constant M circles & N circles.
(ii) Use of digital computers as compensation devices. **(8)**

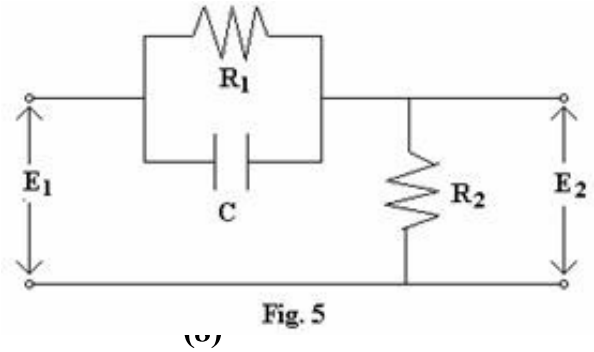

Fig. 5

(c) $\frac{E_2(s)}{E_1(s)} = \frac{1}{a}\left[\frac{1+aTs}{1+Ts}\right]$ for the phase lead network shown in Fig.5. ms of R_1, R_2 and C.

b. Discuss the working of tachogenerator. **(8)**