USN

Fourth Semester B.E. Degree Examination, June / July 08
Control Systems

Time: 3 hrs. Max. Marks:100

Note : ***Answer FIVE full questions, choosing atleast two questions from each part.***

PART - A

1 a. Define control system. Compare open loop and closed loop control system with two examples for each type. **(08 Marks)**

b. Obtain differential equations describing the mechanical system shown in Fig. Q 1(b). Then draw electric circuits based on F – V and F – I analogy. **(12 Marks)**

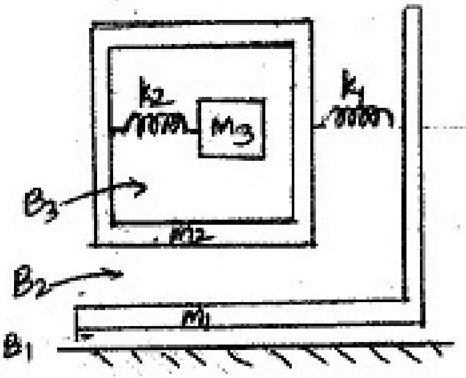

Fig. Q 1(b)

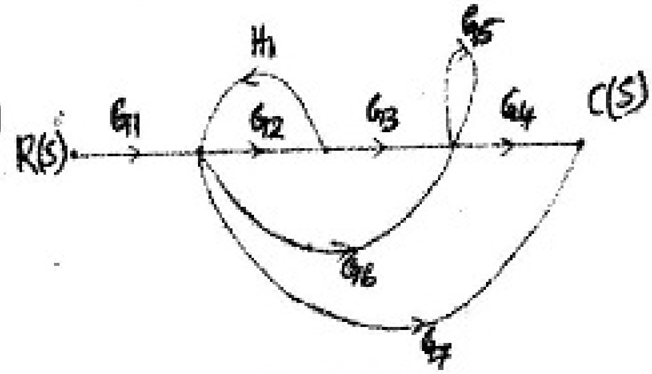

Fig. Q 2(a)

2 a. Find C(S) / R(S) for the signal flow graph shown in Fig. Q 2(a) using Mason's gain formula. **(10 Marks)**

b. Determine the transfer function of a system whose block diagram is given in Fig. Q 2(b) below using the block diagram reduction technique.

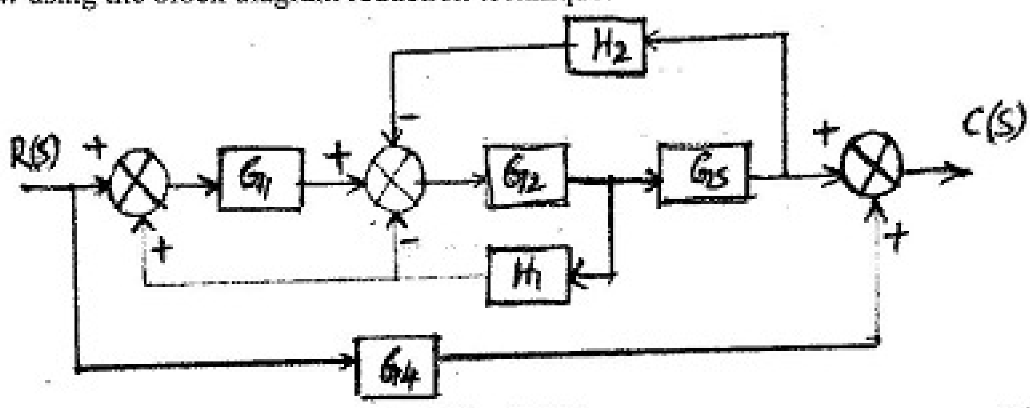

Fig. Q 2(b) **(10 Marks)**

3 a. The open loop transfer function of an unity feed back control system is given by $G(s) = K / S(1 + TS)$ **(08 Marks)**

i) By what factor should the amplifier gain K be multiplied in order that the damping ratio is increased from 0.2 to 0.8?

ii) By what factor should K be multiplied so that the system overshoot for unit step excitation is reduced from 60% to 20%.

b. Find the position, velocity and acceleration error constant for a control system having open loop transfer function $GH(s) = \frac{4}{s(s+1)(s+2)}$. Also determine its steady state error for a unit step, ramp and parabolic inputs. What is the steady state error due to the transform input of $R(S) = \frac{2}{s} - \frac{1}{s^2}$. **(08 Marks)**

c. Derive an expression for generalized error coefficients. **(04 Marks)**

4 a. A system oscillates with a frequency W rad /sec if it has poles at $S = \pm jw$ and no poles in right half of the S – planes. Determine the value of 'K' and 'a' so that the system shown in Fig. Q 4(a) below oscillates at a frequency of 2 rad /sec.

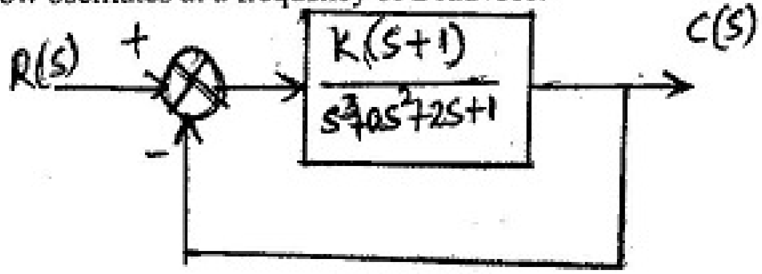

Fig. Q 4(a) **(10 Marks)**

b. Determine the ranges of K such that the characteristic equation $s^3 = (2k+3)s^2(6k+7)s+(7k+8.5)=0$ has roots more negative than $s=-1$. **(10 Marks)**

PART - B

5 a. Sketch the root locus and hence determine :

i) The damping ratio and the corresponding value of K for maximum damped oscillatory response.

ii) The closed loop transfer function corresponding to (i) for a unity feed back system having $G(s)=\frac{k(s+3)}{s(s+2)}$. **(10 Marks)**

b. Discuss with a suitable example the importance of root locus diagram. **(10 Marks)**

6 a. State and explain Nyquist stability criterion. **(08 Marks)**

b. Draw the Nyquist plot for the given open loop transfer function $GH(s)=\frac{10(s+1)}{s^2(1+0.25s)}$.

Determine the stability of the system using Nyquist stability criterion. **(12 Marks)**

7 a. The open loop transfer function of a unity feed back control system in given by $G(s)=\frac{k(s+1)}{s(1+0.1s)^2(1+0.02s)}$

i) Draw the Bode plot and hence find phase margin and gain margin for K = 1.

ii) Determine the value of 'K' for a gain margin of 20 db and the value of 'K' for a phase margin of 30^0. **(14 Marks)**

b. Determine the transfer function of the given system whose Bode magnitude plot is as shown in Fig. Q 7(b).

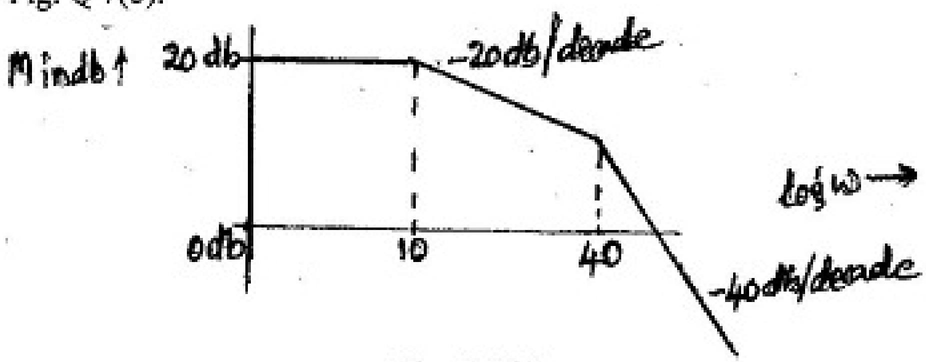

Fig. Q 7(a) **(06 Marks)**

8 a. Write state space equation for the following equation :

$$L_a\frac{di_a}{dt}+R_a i_a+k_b\theta=V_a(t) \text{ and } J\frac{d^2\theta}{dt^2}+f\frac{d\theta}{dt}=T_a(t) \text{ where } T_a(t)=K_t i_a.$$ **(08 Marks)**

b. Write short notes on : **(12 Marks)**

i) State transition matrix ii) State space analysis iii) Phase margin and gain margin.

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