



(Following Paper ID and Roll No. to be filled in your Answer Book)

**PAPER ID : 3088**

Roll No.

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### B. Tech.

#### (SEM. V) EXAMINATION. 2008-09 AUTOMATIC CONTROL SYSTEM

Time : 3 Hours]

[Total Marks : 100

- Note :**
- (1) Answer all questions. All questions carry equal marks.
  - (2) Choices are internal to each question.
  - (3) Answers must be to the point.
  - (4) Assume practicable data in case any are missing.
  - (5) May assume names of missing variables and constants, if necessary.
  - (6) Throughout this paper,  $\omega_n$  represents angular frequency of natural resonance,  $\zeta$  is damping factor.

1 Answer any **four** parts :

- (a) Reduce the block diagram shown in Fig. 1(a) 5 using block diagram algebra and obtain the system transfer function C/R :



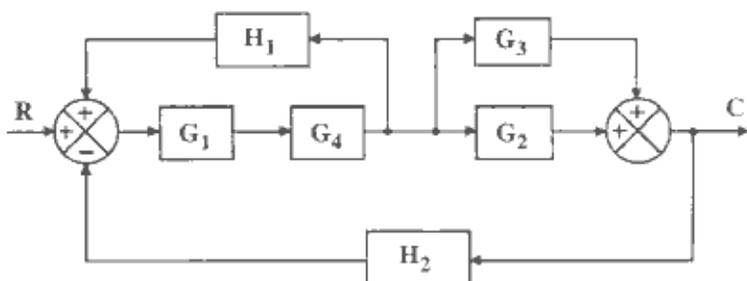


Fig. 1 (a)

- (b) In Fig. 1 (b)  $M_1, M_2$  are mass,  $k_1, k_2$  are 5  
spring constant,  $f_1, f_2$  are coefficient of solid  
friction,  $x_1, x_2$  are displacement and  $F$  is  
force. Is the system linear? Justify your  
answer. Assume that static and dynamic friction  
coefficients are equal :

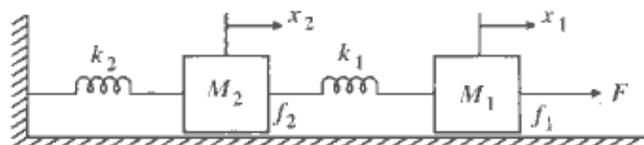


Fig. 1 (b)

- (c) If now in Fig. 1(b),  $f_1, f_2$  are viscous drag 5  
constants instead of coefficient of solid friction,  
comment upon the linearity of the system. With  
 $F$  as input and  $x_1$  as output, what will be the  
order of the system and why ?



- (d) In context of Signal Flow Graph, define : 5
- (i) Input Node
  - (ii) Output Node
  - (iii) Path
  - (iv) Loop
  - (v) Non-touching paths/loops.
- (e) Form the Signal Flow Graph for the system 5  
described in question no. 1 (c).
- (f) Classify the following control systems used at 5  
home as open loop or closed loop :
- (i) Electronic fan regulator and
  - (ii) Electric Iron (to press clothes). Why are closed loop systems considered better ? Why certain open loop systems are still used ?

2 Answer any **four** parts :

- (a) In a control system represented in Fig. 2 (a), 5  
deduce the expression for unit step response.

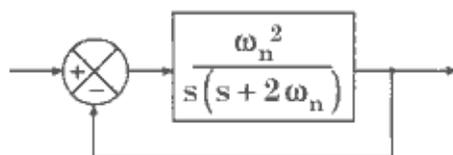


Fig. 2 (a)



- (b) With respect to unit step response of a system 5  
define the following :
- (i) Peak overshoot
  - (ii) Rise time
  - (iii) Delay time
  - (iv) Settling time
  - (v) Steady state error.
- (c) The transfer function of a single order system 5  
is given as :

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

Find the settling time for step response.

Tolerance band is  $\pm 10\%$ .

- (d) Explain dynamic error constants and their utility. 5
- (e) What purpose may derivative error compensation 5  
serve ? How does it affect important transient  
specifications like peak overshoot and settling  
time ?
- (f) Compute the Integral Square Error of an under- 5  
damped standard second order system for its  
unit step response given as (with  $\text{Cos}^{-1}\zeta$  in  
first quadrant) :

$$C(t) = 1 - \frac{e^{-\zeta\omega_n t}}{\sqrt{(1-\zeta^2)}} \cdot \text{Sin} \left[ \sqrt{(1-\zeta^2)} \omega_n t + \text{Cos}^{-1}\zeta \right]$$



3 Answer any **two** parts :

- (a) In the control system shown in figure-3(a), first assume  $K=1$  and plot the asymptotic magnitude and phase Bode Plots for the forward path gain  $G(s)$  on a semilog graph paper. Assuming these asymptotic plots to be accurate, find the Gain Margin and Phase Margin. From the plot also compute the value of  $K$  where the system just becomes unstable. 10

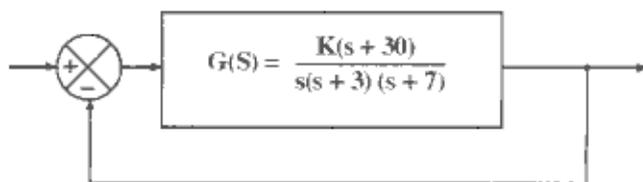


Fig. 3 (a)

- (b) Write a note to explain Nyquist plot with examples. How it helps in stability analysis? What happens to the Nyquist contour when there are open loop poles on the imaginary axis? 10

**OR**

Write a note on Root Locus, its construction and utility.



- (c) Although practically only the time response of 10  
a control system matters, the frequency response  
is still studied in detail. Why is it so ?

Explain the correlation between the frequency  
response and the unit step response of a simple  
second order system. Emphasize on how can  
one find out the time domain specifications  
from the frequency response.

4 Answer any **two** parts :

- (a) Under what circumstances lag compensators 10  
are used in cascade ? Explain the use of cascade  
lag compensator to improve the performance of  
a system by root locus method. Why under most  
circumstances, the pole and the zero of the lag  
compensator are placed close to each other and  
also to the origin ?
- (b) Bode plot of a control system shows insufficient 10  
phase margin. To improve upon it, you want to  
place a compensator in cascade. What type of  
compensator will you use ? Explain the design  
process with an example.
- (c) Write a short note on circuit implementation of 10  
simple compensators.



5. Answer any **two** parts :

- (a) For the system described in question no. 1(c) **10**  
choose suitable state variables and form the state  
equations. Is your state transition matrix in any  
canonical form ?
- (b) Define the **exponential** of a matrix. Explain why **10**  
Jordan canonical form matrices are important for  
easy solution of state equations.
- (c) Write a note on (any **one**) : **10**  
Fuzzy Control

**OR**

Application of Neural Networks in Control  
Engineering.

