

Printed Pages—7

EE—507

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

**PAPER ID : 2008**

Roll No.

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**B.Tech.**

FIFTH SEMESTER EXAMINATION, 2004-2005

**AUTOMATIC CONTROL SYSTEM**

Time : 3 Hours

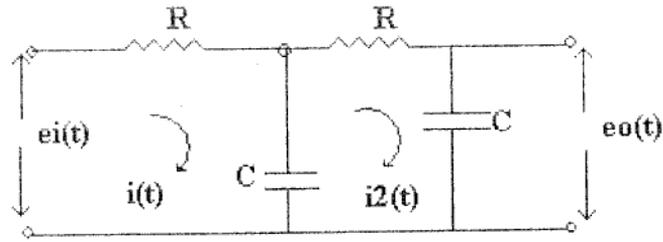
Total Marks : 100

**Note :** Attempt ALL the questions.1. Attempt *any four* parts of the following : [5x4=20]

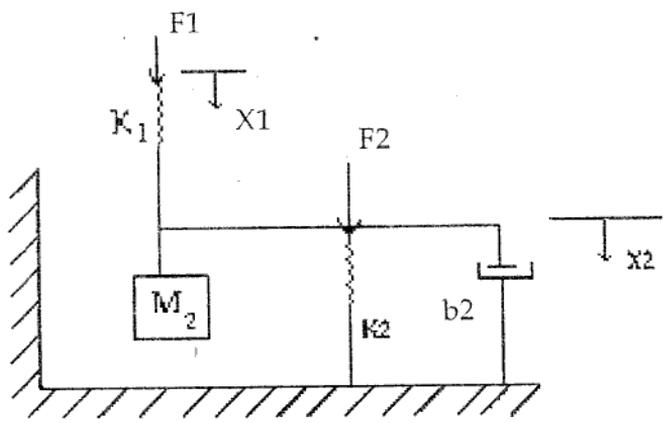
- (a) Explain the effect of feed back on transient response, system sensitivity, bandwidth, gain and system stability.
- (b) (i) Define the following terms time delay, rise time, setting time, peak overshoot.
- (ii) Find the response as 't' approaching infinity of a system having transfer function  $\frac{C(s)}{R(s)} = \frac{8}{s(s+4)}$  to unit step input.
- (c) What is effect of adding a pole to a system? Discuss.
- (d) (i) What is feed forward compensation ? Clearly show block diagram.


  
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- (ii) What is Mason's gain formula? Define each term therein.
  
- (e) Define the transfer function. Find the transfer function of the network given in fig below.



- (f) Find the transfer function matrix for the system below, assuming  $F_1$  and  $F_2$  as the two components of input force vector and  $X_1$  and  $X_2$  as the two components of the output position vector in Laplace transfer form.



2. Attempt *any four* parts of the following : (4x5=20)

(a) A low inertia plotter can be represented by the block diagram in fig below.

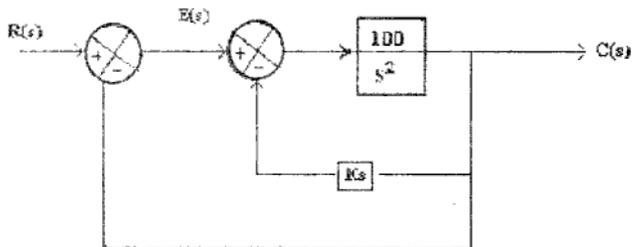


Fig. 2a

- (i) Calculate the value of velocity gain  $k$  such that the system is non oscillatory yet has the lowest possible setting time to step input.
- (ii) Find the steady-state error for ramp input.
- (b) What are M & N circles? Explain the physical significance of these circles in stability study.
- (c) Explain the steps for constructing the polar plots. Draw the inverse polar plot of the circuit shown in fig 2 (c).

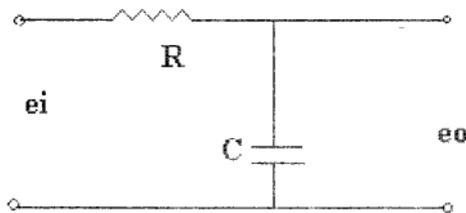


Fig 2 (c)

- (d) Discuss the general procedure of determination of transfer function from Bode plot.
- (e) Draw the approximate Bode plot of gain  $V/s$   $\log w$  for the conditionally stable system described by expression.

$$G(s) = \frac{930(1+0.5s)^2}{s(1+5s)^2 (1+0.03s)}$$

starting from  $\omega = 0.1$  rad/s

- (f) Determine the correlation between time and frequency response for second order system and also show impact of damping on band width.

3. Attempt *any two* parts of the following : [10x2=20]

- (a) (i) Consider the system

$$x_1 = -x_2 + \alpha x_1^3$$

$$x_2 = x_1 + \alpha x_2^3$$

Discuss the stability in the sense of Lyapunov.

- (ii) Use Routh's criterion to investigate the stability of the open loop system given by transfer functions

$$G(s) = K / \{s(s+2)(s^2+3)\}$$
 with unity feed back.

- (b) (i) What are steps for constructing Root locus? Enlist them.
- (ii) Consider the loop transfer function

$$G(s) H(s) = K(s+2) / \{s^2+2s+2\}$$

Construct the root locus of above given function and comment on stability.

- (c) Consider a feedback control system with the loop transfer function given as

$$G(s)H(s) = 5 / \{s(1-s)\}$$

State about system stability by Nyquist criterion.

4. Attempt *any two* parts of the following : [10x2=20]

- (a) Discuss about Lag-lead compensation with suitable diagram and also represent on s-plan clearly.
- (b) Consider a feedback control system with the open-loop transfer function with unity feed back.

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

The required specifications are

- (i) The phase margin of the system must be greater than  $45^\circ$ .
- (ii) When the input is a step velocity (ramp) function, the steady state error of the output in positive should be less than 0.1 deg/deg/sec of the final output velocity.

Design a phase - lead compensation by Bode plot and clearly show specific points on plot .

- (c) Explain about phase lag compensation by Root locus Method with proper expression and plot.

5. Attempt *any two* parts of the following : [10x2=20]

- (a) (i) Define and state the physical significance of following terms :

Phase variables, state-space, eigen-value, canonical variables, companion variables.

- (ii) Define and explain the controllability and observability with a suitable example.

- (b) Consider a single-input-single output control system having an overall transfer function  $T(s)$  given by

$$T(s) = \frac{s^2 + 4s + 4}{s^3 + 5s^2 + 4s}$$

Represents the system state model in terms of the canonical variables and determine a set of coefficients matrix  $A, B, C$ .

- (c) (i) Consider the third order system

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \\ \dot{X}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -30 & -11 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} U$$

$$Y = [1 \ 0 \ 0] \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix}$$

Find the suitable modal matrix such that the poles are at  $s = -2, -5, -6$ .

(ii) Find the state-space representation using physical variables of network given below.

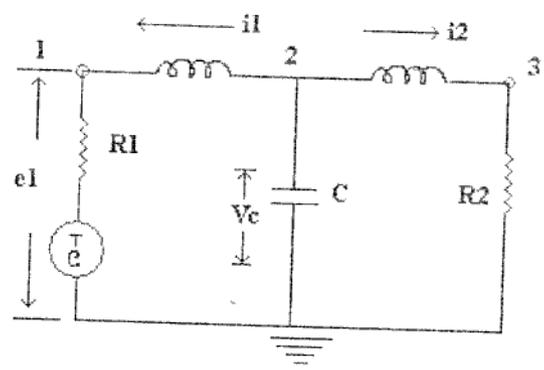


Fig. 5 c

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