Reg. No. : E N G G T R E E . C O M

Question Paper Code : 51016

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2024.

Fifth Semester

Electrical and Electronics Engineering

EE 3503 — CONTROL SYSTEMS

(Regulations 2021)

Time : Three hours Maximum : 100 marks

(Semi log sheets and polar sheets may be permitted)

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. List any two advantages of closed loop control system.

2. Write the characteristics of feed back control system.

3. Name any two standard test signals.

4. Write the condition for the system to be stable.

5. List any two frequency domain specifications.

6. Define phase cross over frequency.

7. List any two properties of state transition matrix.

8. Define controllability.

9. List any one advantages of using lag compensator.

10. Give the tuning method for PID controller design.

PART B — (5 × 13 = 65 marks)

11. (a) Build the transfer functions of the mechanical systems as shown in Figure 1.

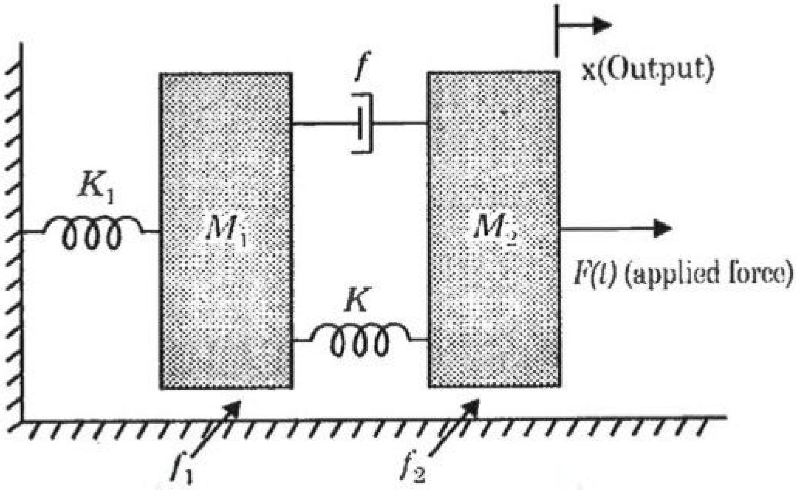

Figure. 1

Or

(b) Develop the overall transfer function C/R from the signal flow graph as shown in Figure. 2.

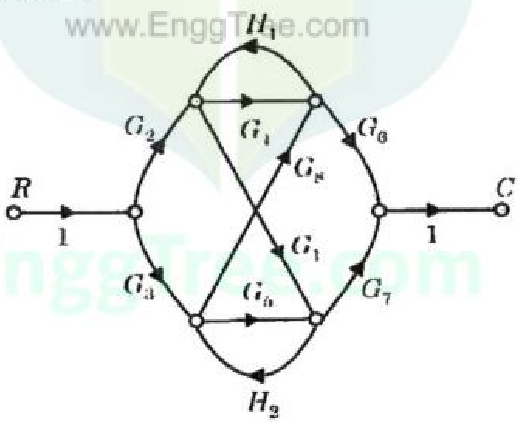

Figure. 2

12. (a) Construct an expression for an under damped second order system response for a unit step input.

Or

(b) Analyze the stability of the following characteristic equation using Rough criterion

$$s^5 + s^4 + 3s^3 + 9s^2 + 16s + 10 = 0$$

Also determine the number of roots lying one the right half of s-plane.

13. (a) Construct the bode plot of the following open loop transfer function and determine the gain cross over frequency.

$$G(s) = \frac{5(1+2s)}{s(4s+1)(0.25s+1)}$$

Or

(b) Draw the polar plot and obtain gain and phase margin of the following system.

$$G(s) = \frac{1}{(s+1)(2s+1)}$$

14. (a) (i) A linear time invariant system is characterized by the homogeneous state equation (6)

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Compute the solution by assuming $X(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$.

(ii) Consider now that the system has a forcing function and is represented by the non-homogeneous state equation. (7)

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$$

Where u is a unit-step input? Compute the solution by assuming initial conditions of part (i).

Or

(b) Determine the controllability and observability of the following system.

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} -2 & 1 \\ 1 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$$

$$y = [1 \quad -1] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

15. (a) Explain in detail about the procedure to obtain the controller settings using Process Reaction Curve method.

Or

(b) With neat block diagram explain controller tuning using Ziegler-Nichols method.

PART C — (1 × 15 = 15 marks)

16. (a) Consider a type-1 unity feedback system with an open-loop transfer function

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

Design a suitable lead compensator in frequency domain with $K_v = 12$ sec^{-1}. PM = 40 degrees.

Or

(b) A unit feedback system is characterized by the open-loop transfer function

$$G(s) = \frac{4}{s(2s+1)}$$

It is desired to obtain a phase margin of 40 degrees without sacrificing the K_v of the system. Design a suitable lag-network and compute the value of network components assuming any suitable impedance level.