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# SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

**FIFTH SEMESTER B.TECH DEGREE EXAMINATION (Regular), DECEMBER 2022**
**ELECTRONICS AND COMMUNICATION ENGINEERING**
**(2020 SCHEME)**

**Course Code:** **20ECT307**

**Course Name:** **Control Systems**

**Max. Marks :** **100** **Duration: 3 Hours**

***Instructions: Graph sheets and semi log sheets are to be provided***

## PART A

***(Answer all questions. Each question carries 3 marks)***

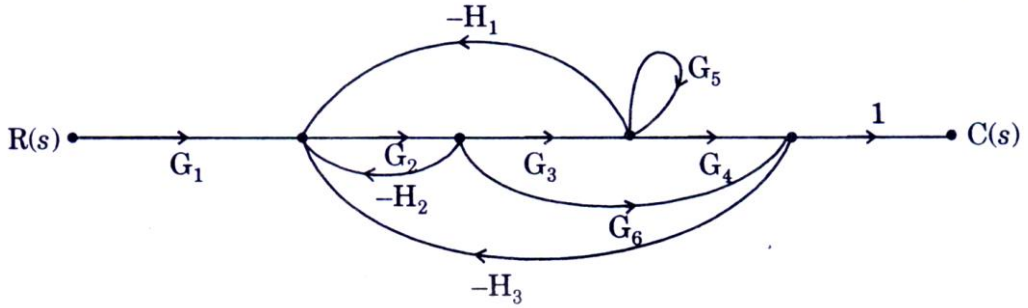
1. Differentiate between open loop and closed loop system.
2. Explain linear control system with a suitable example.
3. Define the term (i) Rise Time (ii) Settling Time in the time domain specifications.
4. Sketch the time response of first order systems for unit step input.
5. What is BIBO stability? Explain with a suitable example.
6. Discuss clearly the effect of addition of poles and zeros on root locus.
7. Differentiate between gain margin and phase margin.
8. Explain Nyquist stability criteria.
9. List the advantages of state space analysis.
10. Find the state transition matrix, $e^{At}$ for $A = \begin{bmatrix} 0 & -1 \\ -2 & -3 \end{bmatrix}$.

## PART B

***(Answer one full question from each module, each question carries 14 marks)***

### MODULE I

11. a) Using Mason's formula find C/R

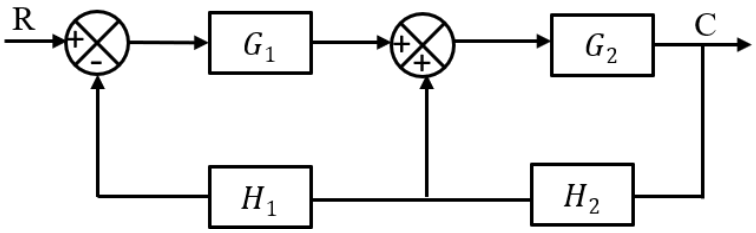



(9)

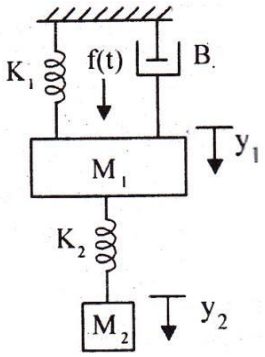
b) With a neat sketch explain the basic components of a control system. (5)

**OR**

12. a) From the block diagram shown in Figure, determine C/R. (5)

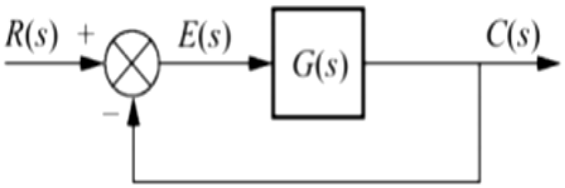



b) Determine the transfer function $\frac{Y_2(S)}{F(S)}$ of the system shown in figure. (9)




**MODULE II**

13. a) Obtain the response c(t) of the system shown in figure when the input is unit step $G(s) = \frac{10}{s^2 + 10s + 25}$. (7)




b) Write the governing equation of the second order system. Classify the system based on the damping ratio. Also, mark poles in S plane and plot the step response of each system. (7)

**OR**

14. a) What is steady state error? Also explain static error coefficients. (8)

b) Explain the correlation between time and frequency domain responses. (6)

## MODULE III

15. a) Explain R-H criterion with relevant equations. (5)

b) Construct Routh array and determine the stability of the system whose characteristic equation is $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$. Comment on the location of the roots of characteristic equation. (9)

**OR**

16. a) Explain the PID controller with necessary equations (4)

b) Plot the complete root loci for the system whose open loop transfer function is given by (10)

$$G(s)H(s) = \frac{K(0.5+S)}{S(1+S)(2+S))}$$

## MODULE IV

17. a) Explain the need of compensators in control systems.

b) Explain in detail about the design procedure of lag compensators using Bode plots. (10)

**OR**

18. Sketch Bode plot for the following transfer function and determine the system gain K for the gain cross over frequency to be 5rad/sec. (14)

$$G(s) = \frac{Ks^2}{(1 + 0.2s)(1 + 0.02s)}$$

## MODULE V

19. a) (9)

Check whether the system represented by the state equation is completely controllable.

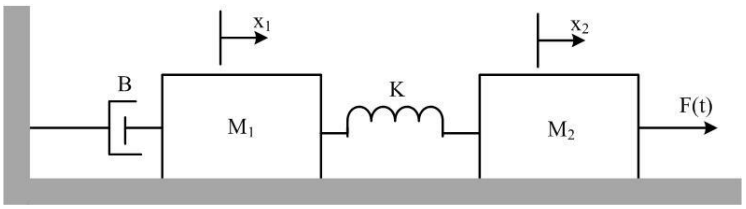
$$\dot{X} = \begin{bmatrix} -7 & -2 & 6 \\ 2 & -3 & -2 \\ -2 & -2 & 1 \end{bmatrix} X + \begin{bmatrix} 1 & 1 \\ 1 & -1 \\ 1 & 0 \end{bmatrix} U$$

b) State and prove the Properties of State transition matrix. (5)

**OR**

20. a) State Kalman's test for Observability. (4)

b) Find the state equations for the mechanical system shown in Figure below. (10)

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