

C. U. SHAH UNIVERSITY
Summer Examination-2022

Subject Name: Linear Control Theory

Subject Code: 4TE05LCT1

Branch: B.Tech (Electrical)

Semester: 5

Date: 25/04/2022

Time: 11:00 To 02:00

Marks: 70

Instructions:

- (1) Use of Programmable calculator & any other electronic instrument is prohibited.
- (2) Instructions written on main answer book are strictly to be obeyed.
- (3) Draw neat diagrams and figures (if necessary) at right places.
- (4) Assume suitable data if needed.

Q-1 Attempt the following questions: (14)

- a) What is control system?
- b) Define relative stability.
- c) Define: error
- d) What is the damping factor of undamped system?
- e) What should be the damping factor of a Lift?
- f) How to find mathematical model?
- g) Define non-linear system.
- h) Give the name of any one method to find absolute stability.
- i) What is the use of signal flow graph?
- j) What is the effect of a non-minimum phase system?
- k) What is the Laplace transform of dx/dt?
- l) What is the starting point of root locus?
- m) Define resonance peak in the Bode plot.
- n) Can we assign initial conditions in state space analysis?

Attempt any four questions from Q-2 to Q-8

Q-2 Attempt all questions (3)

(a) List advantages and disadvantages of transfer function (3)

(b) Explain open loop control system and closed loop control system with block diagram and examples. (4)

(c) Consider the system shown in figure:1, R, L, C is electrical parameters while K, M, and B are mechanical parameters as shown. Find the transfer function $\frac{X(s)}{E_1(s)}$ for the system where $e_1(t)$ is input voltage while $x(t)$ is output displacement. (7)



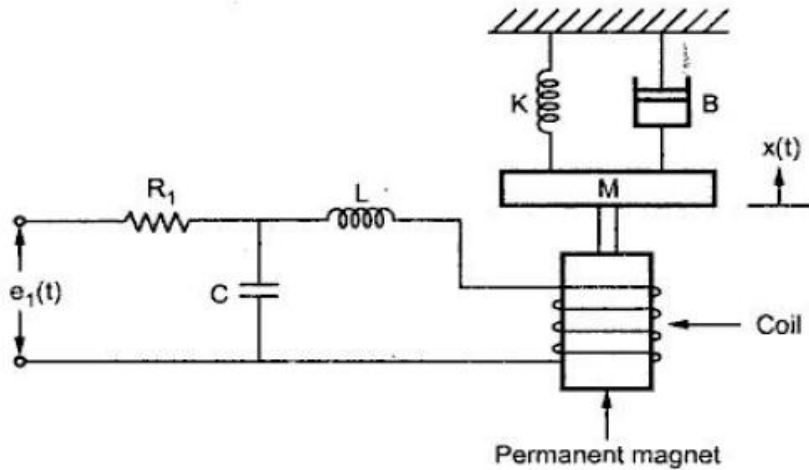


Figure: 1

Q-3 Attempt all questions

- (a) What is state space model? Define states. Derive the expression for converting state model to transfer function? (7)
- (b) Sketch Bode plots of a unity feedback control system having open-loop transfer function as given below. The magnitude plot of this function should be an exact one and not an approximation. Find the GM and PM (7)

$$G(s) = \frac{10(0.5s+1)}{s(0.1s+1)(0.2s+1)}$$

Q-4 Attempt all questions

- (a) A unity feedback control system's open loop transfer function is (7)

$$G(s)H(s) = \frac{k(s + 13)}{s(s + 3)(s + 7)}$$

Using Routh criterion, calculate the range of k for the system to be stable. If the value of k=1, comment on stability.

- (b) What is Root Locus? Write the various rules for drawing root locus (7)

Q-5 Attempt all questions

- (a) Draw the root-locus for open-loop transfer function (7)

$$G(s) = \frac{K}{s(s+3)(s^2+2s+1)}$$

When K is varied from 0 to infinity.

- (b) Draw unit step response of a second order control systems. Describe all specification in detail. (7)

Q-6 Attempt all questions

- (a) Derive the equation of Peak time and Peak overshoot for under damped second order system. (7)

- (b) Using block diagram reduction rules find the overall transfer function of figure:2. (7)



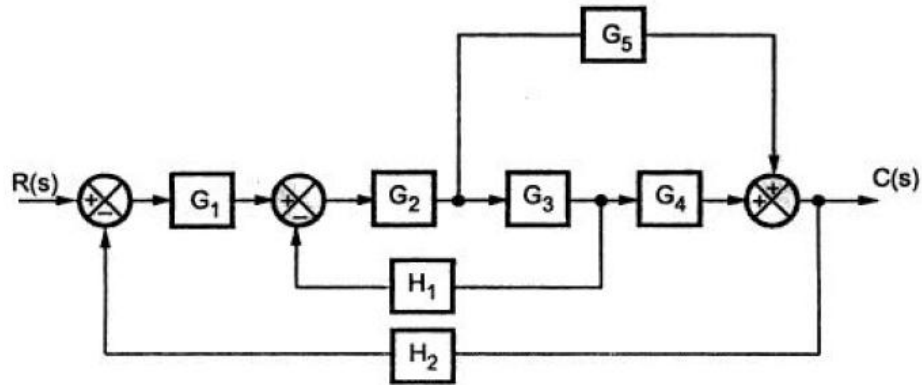


Figure:2

Q-7 Attempt all questions

- (a) Derive steady state errors for unit step, unit ramp and unit parabolic input. (3)
- (b) Write Meason's gain formula and define each term of the formula. (4)
- (c) Explain absolute stability, relative stability and BIBO stability. (7)

Q-8 Attempt all questions

- (a) Draw the Bode plot for (7)

$$G(s) = \frac{10(1 + 0.5s)}{s(1 + 0.1s)(1 + 0.2s)}$$

Also find phase and gain margin.

- (b) Determine the State Variable System determined by (7)

$$T(s) = \frac{Y(s)}{R(s)} = \frac{4(s+3)}{(s+2)(s+1)}$$

