

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

Paper ID : 2289454

Roll No.

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## B.TECH.

Regular Theory Examination (Odd Sem-V) 2016-17

### CONTROL SYSTEMS - I

Time : 3 Hours

Max. Marks : 100

#### Section - A

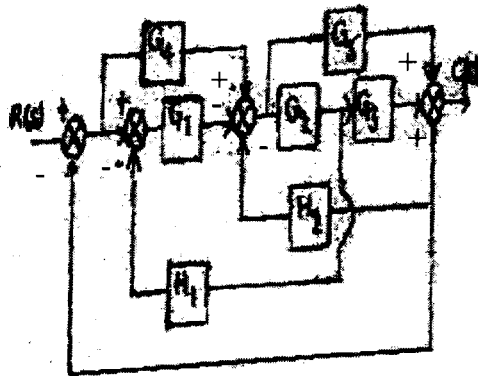
1. Attempt all parts. All parts carry equal marks. Write answer of each part in short. (10×2=20)
- Distinguish between open loop and closed loop control system.
  - Write the analogous electrical elements in force voltage analogy for the elements of mechanical translational system.
  - Derive the step response of a first order system.
  - Why negative feedback is invariably preferred in closed loop system?
  - What are the basic properties of signal flow graph?
  - What is a polar plot?
  - What do you understand by type and order of a system?
  - What is servomechanism?

- i) State angle and magnitude criteria in root locus.
- j) Define state, State Variable State Space State Vector.

**Section - B**

2. Attempt any five parts from this section. (5×10=50)

- a) Determine the transfer function C(s)/R(s) for the block diagram shown in figure given below by using Block Diagram Reduction Method.



- b) Construct the state model for a system characterized by differential equation:-

$$\frac{d^3 y}{dt^3} = 6 \frac{d^2 y}{dt^2} + 11 \frac{dy}{dt} + 6y = u$$

Give block diagram and signal flow graph representation of the state model.

- c) A unity feedback control system is characterized by an open-loop transfer function

$$G(s)H(s) = \frac{K}{s(s+10)}$$

Determine the system gain K, so that the system will have a damping ratio of 0.5. For this value of K, find the rise time, peak time, settling time and peak overshoot.

- d) i) Explain the correlation between Transfer function and state space equations.
- ii) Derive the transfer function for Armature controlled DC Servo motor.

- e) Obtain the time response of the following system:

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$$

where u(t) is a unit step occurring at t = 0 and  $X^T(0) = [1 \ 0]$

- f) i) Draw the response of second order system for critically damped case and when input is unit step.
- ii) Derive the expressions for Rise time, Peak time, and peak overshoot.

- g) The open loop transfer function of a system is  $G(s)H(s) = \frac{k(s+1)}{(s^3+bs^2+3s+1)}$ . Determine the values of 'k' & 'b' so that system will oscillate at frequency of 2rad/sec by using R-H criteria.

- h) What is the role of sensors and encoders in control system? Explain the construction and principle of potentiometer.

## Section - C

**Note:** Attempt any two questions from this section.

(2×15=30)

3. Sketch the root loci for the open loop transfer function given below (The gain K is assumed to be positive) and determine whether a system is stable or not:

$$G(s)H(s) = \frac{k}{s(s+1)(s^2 + 4s + 13)}$$

4. Sketch the bode plot of the system given by:

$$G(s)H(s) = \frac{k}{s(s+0.5)(s^2 + 0.6s + 10)}$$
 and determine the stability of the system.

5. State Nyquist stability criterion. Investigate the stability of a closed loop system with open loop transfer function given by:

$$G(s)H(s) = \frac{K(s+3)}{s(s-1)}$$

by using Nyquist plot. Also find the value of Gain margin.