Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) - EXAMINATION – SUMMER 2016

Subject Code:2151908 **Date:17/05/2016**

Subject Name:Control Engineering

Time:02:30 PM to 05:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Derive transfer function of room heating system with usual notations. **07**

(b) Draw the analogous electric circuit considering Force-Voltage analogy for the mechanical system shown in figure 1 where x_i is the input displacement, x_0 is the output displacement, y is the displacement of the spring, D_1, D_2 are the viscous damping coefficients and K_1, K_2 are the compliances of the springs. Also obtain the transfer function for this mechanical system. **07**

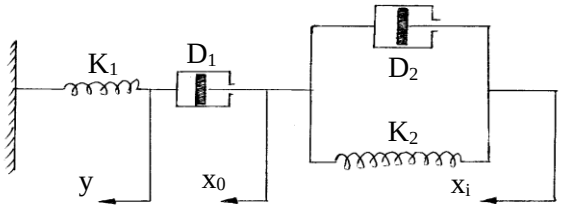

Figure 1

Q.2 **(a)** Derive unit-step response for first-order control system. Discuss salient features of the response curve and error curve with a neat sketch. **07**

(b) Determine the overall transfer function for the block diagram shown in figure 2 using block diagram reduction. **07**

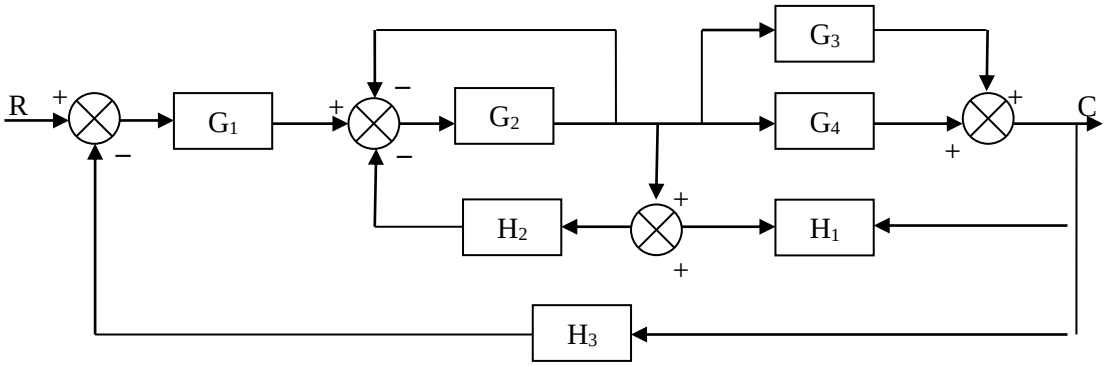

Figure 2

OR

(b) Determine the transfer function by the Mason's Gain formula for the Signal Flow Graph shown in figure 3. **07**

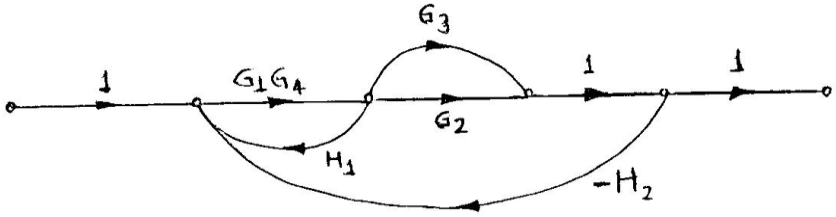

Figure 3

Q.3 **(a)** For the system shown in figure 4, determine the value of gain K and velocity-feedback constant K_h so that the maximum overshoot in the unit-step response is 0.2 and the peak time is 1 sec. With these values of K and K_h, obtain the rise time and settling time for 2% criterion. Assume that J = 1kg-m^2 and B = 1 N-m/rad/sec. **07**

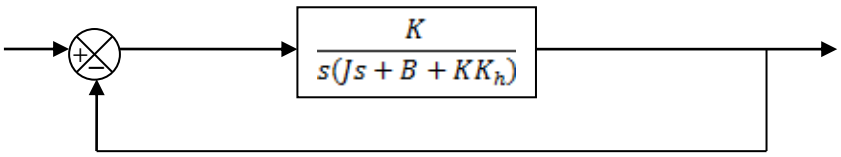

Figure 4

(b) Determine the stability of a system whose overall transfer function is given below: **07**

$$\frac{C(s)}{R(s)} = \frac{2s+5}{s^5 + 1.5s^4 + 2s^3 + 4s^2 + 5s + 10}$$

If the system is found unstable, how many roots it has with positive real part ?

OR

Q.3 **(a)** Derive unit impulse response for a generalized second order system for underdamped, critically damped and overdamped cases with usual notations. Also derive the relation of maximum overshoot (for underdamped case). **07**

(b) Discuss stepwise procedure of plotting the root-locus for a given open-loop transfer function. **07**

Q.4 **(a)** Explain the schematics to achieve Hydraulic Proportional-Plus-Derivative Control action with a neat sketch in brief. Draw block diagram and obtain transfer function for the same. **07**

(b) Explain Force-Distance type Pneumatic Proportional controller and derive transfer function for it. **07**

OR

Q.4 **(a)** Draw a neat sketch of generalized hydraulic control system. Explain the elements of hydraulic control system in brief. **07**

(b) Explain working of schematics to achieve Pneumatic PID controller in brief with a neat sketch. Draw block diagram and obtain transfer function for the same. **07**

Q.5 **(a)** Explain the concept of state used in modern control theory and briefly explain the state space representation of Mechanical system. **07**

(b) Explain the terms Gain Margin and Phase Margin related to Frequency response analysis of Control Systems. **07**

OR

Q.5 **(a)** Discuss the advantages of State Space analysis over Classical Technique used for control systems analysis. Also explain the state space representation of second order differential equation. **07**

(b) Briefly discuss performance specifications of frequency response analysis for linear controls systems. **07**

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