Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

PDDC - SEMESTER–III • EXAMINATION – SUMMER 2013

Subject Code: X 30903 **Date: 15-05-2013**

Subject Name: Control Theory

Time: 02.30 pm - 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)** Discuss translational-rotational elements. **07**

(b) Find out the transfer function using Mason's Gain Formula for the block diagram: (fig. 1). **07**

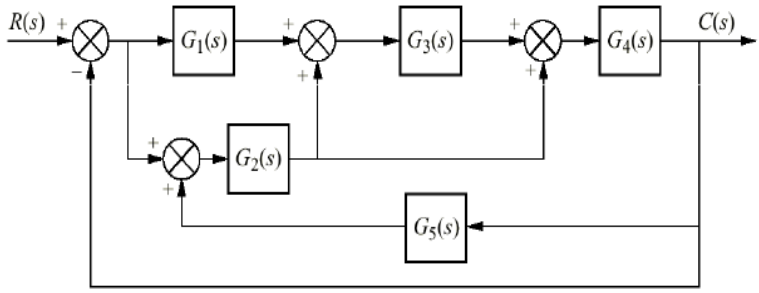

Fig. 1

Q.2 **(a)** Compare the Closed Loop System and Open Loop System. Draw the block diagram for an automatic temperature controlled a class room of your college. **07**

(b) Draw the block diagram for the following Mechanical Systems and derive the transfer function: (fig.2) **07**

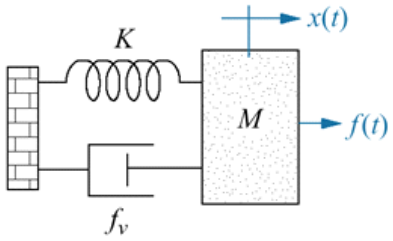

Fig. 2

OR

(b) Draw the block diagram for the following Mechanical Systems and derive the transfer function: (fig.3) **07**

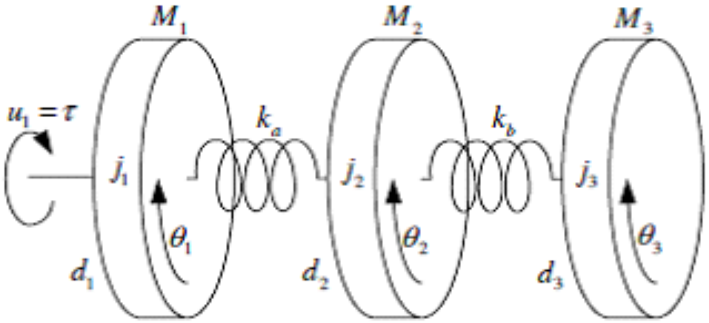

Fig. 3

Q.3 **(a)** Explain force-voltage analogy with suitable example. **07**

(b) Define the following terms: **07**

a) Phase Margin b) Gain Margin

c) Non touching Loop d) Loop Gain

e) Closed Loop System f) Feedback g) Overshoot

OR

Q.3 **(a)** Explain force-current analogy with suitable example. **07**

(b) Define the following terms: **07**

a) Delay Time b) Rise Time

c) Settling Time d) Peak Time

e) Steady State Error f) Mason's Gain Formula

g) Maximum Overshoot

Q.4 **(a)** Draw the Bode Plot for the following Transfer Function: **07**

$10/(1+s)(4+s)$

(b) Second order control system is depicted by: **07**

$$\frac{C(s)}{R(s)} = \frac{\omega_n^{\,2}}{s^2 + 2\delta\omega_n s + \omega_n^{\,2}}.$$

A unit step is applied. Find the time response c(t) if (i) $\delta=1$ and (ii) $0 < \delta < 1$.

OR

Q.4 **(a)** Draw the Bode Plot for the following Transfer Function: **07**

$1/s(1+s)^2$

Q.4 **(b)** Derive an expression for peak time t_p, rise time t_r and maximum overshoot in terms of natural frequency ω_n and damping ratio ξ for a second order control system. **07**

Q.5 **(a)** Draw the Nyquist Plot for the following Transfer Function: **07**

$$10/s^2\ (1+s)(1+2s)$$

(b) Consider a system with characteristic equation given below. Using R-H criterion comments on its stability and find the number of roots in the right-half of the s-plane if any. **07**

$$s^5 + s^4 + 2s^3 + 2s^2 + 3s + 5 = 0$$

OR

Q.5 **(a)** Draw the Nyquist Plot for the following Transfer Function: **07**

$$(1+0.2s)(1+0.025s)/s^3(1+0.005s)(1+0.001s)$$

(b) For a unity feedback system having an open-loop transfer function: **07**

$$G(s)\frac{K(s+2)(s+3)}{s^2(s^2+8s+15)}$$

Determine (a) type of system, (b) error constants Kp, Kv and Ka and
(c) steady-state error for unit step, unit ramp and unit parabolic inputs.

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