Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. - SEMESTER – VI • EXAMINATION – WINTER 2012

Subject code: 160104 Date: 05/01/2013

Subject Name: Basic Control Theory

Time: 02.30 pm - 05.00 pm Total Marks: 70

Instructions:

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

Q.1 **(a)** Attempt all. (Each question carries one mark.) **07**

1. The Laplace Transform of delayed step function $Au(t-T)$ is
   a. e^{-Ts}/A b. Ae^{-Ts}/s
   c. e^{-Ts}/s d. None of these
2. The large time constant corresponds to
   a. Sluggish system b. Faster system
   c. Overdamped system d. Underdamped system
3. The poles of stable second order under damped system are
   a. Purely imaginary b. Complex conjugate of each other
   c. Real and equal d. Real and unequal
4. If the gain of critically damped system is increased, the system becomes
   a. Overdamped b. Underdamped
   c. Undamped d. No effect of gain
5. The roots of the characteristic equation is the same as
   a. Closed loop transfer function b. Open loop transfer function
   c. Forward path transfer function d. None of these
6. If the system has multiple poles on $j\omega$ axis then the system is
   a. Stable b. Unstable
   c. Marginally stable d. Conditionally stable
7. If the system having gain margin of 0 dB then the system is
   a. Stable b. Unstable
   c. Marginally stable d. Conditionally stable

(b) Obtain the transfer function using block diagram reduction technique for the system whose block diagram is given in Fig. 1. **07**

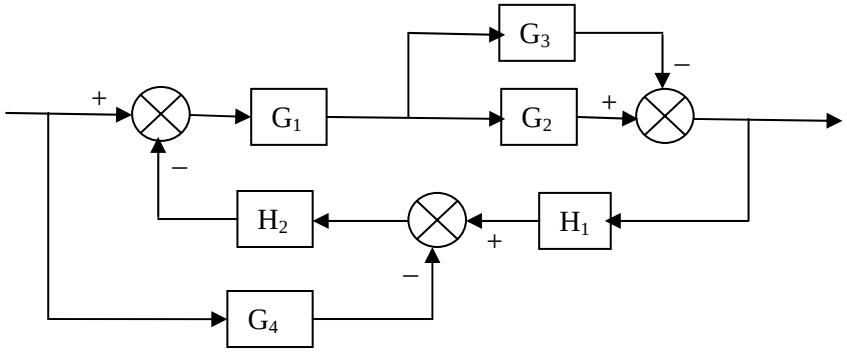

Figure 1.

Q.2 **(a)** Using the Mason's Gain Formula, find the overall gain for the signal flow graph shown in Fig. 3. **07**

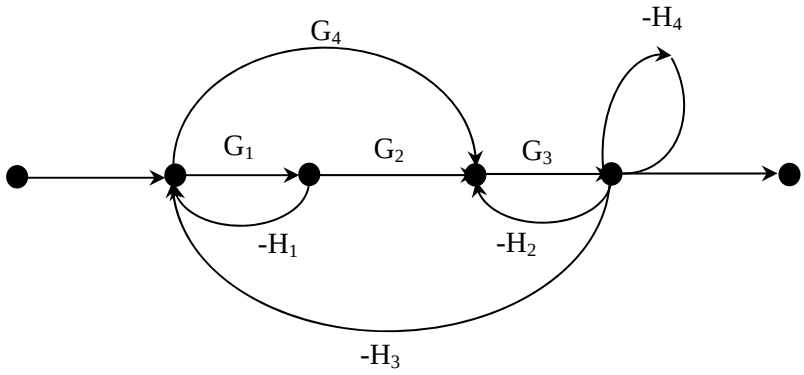

Figure 2.

(b) Derive the overall Transfer Function of armature controlled DC servomotor with block diagram. **07**

OR

(b) Write the differential equations describing the system shown in Fig. 3 below and obtain the system Transfer Function model for X(s)/F(s). **07**

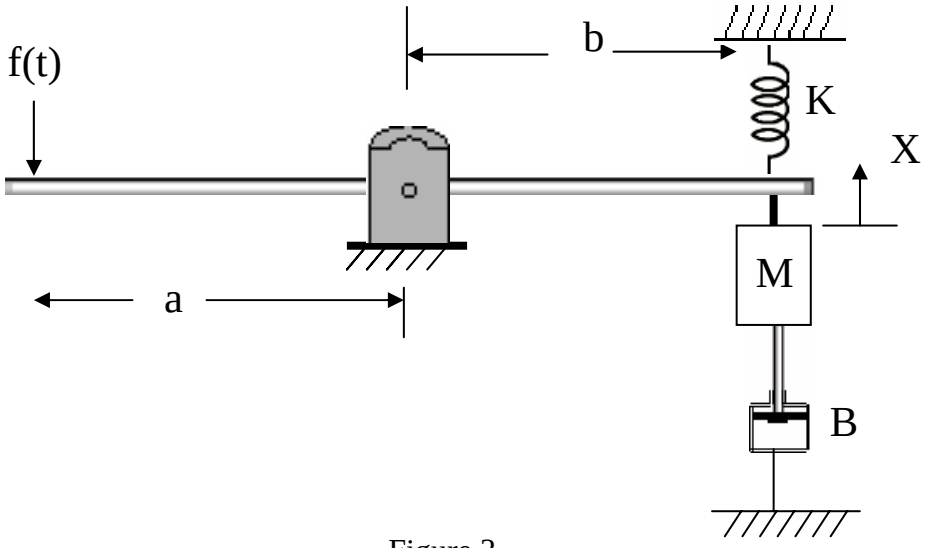

Figure 3

Q.3 **(a)** What is analogous system? Establish Force – Voltage and Force – Current analogy. **07**

(b) A transfer function model of a second order system is given by **07**

$$\frac{C(s)}{R(s)} = \frac{25}{s^2 + 6s + 25}.$$

If the system is subjected to unit step input, calculate the response of the system and also the system specifications such as rise time, peak time, peak overshoot and settling time.

OR

Q.3 **(a)** Define the type of the system and derive the steady state error for the type '2' system for step, ramp and parabolic input. **07**

(b) Discuss effects of the Proportional Integral (PI) and Proportional Derivative (PD) action on closed loop performance. **07**

Q.4 **(a)** Discuss stability with respect to pole location. **07**

(b) 1. Check the stability of the system (use R-H criterion) given by the characteristic equation **04**

$$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0 .$$

2. For the given system characteristic equation **03**

$$s^4 + 22s^3 + 10s^2 + s + K = 0 ,$$

Find K_{mar} and corresponding frequency using R-H criterion.

OR

Q.4 **(a)** State the rules for constructing the Root Locus. **07**

(b) Sketch the Root Locus for the system with **07**

$$G(s)H(s) = \frac{K(s+4)}{s(s^2+2s+2)}$$

Q.5 **(a)** Define the following frequency response specifications: 1. Badwidth, 2. Cut-off frequency, 3. Gain Margin, 4. Gain cross over frequency, 5. Phase Margin 6. Phase cross over frequency, 7.. Resonance frequency **07**

(b) Sketch the bode plots for the unity feedback control system with open loop transfer function given by **07**

$$G(s) = \frac{80}{s(s+2)(s+20)}$$

and determine the gain margin, phase margin, gain cross over frequency, phase cross over frequency. Is the system stable?

OR

Q.5 **(a)** Explain the Nyquist stability criterion for the closed loop system. **07**

(b) Co-relate the Time domain specifications and Frequency domain specifications for the second order system. **07**

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