Seat No.: _____ Enrolment No.______

GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. Sem-VI Examination May 2011

Subject code: 160104

Subject Name: Basic Control Theory

Date:21/05/2011 **Time: 10.30 am – 01.00 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) Attempt all. (Each question carries one mark.) **07**

1. The transfer function is defined only for
   a.linear time varying system **b.**linear time invariant system
   c.linear and non-linear system **d.**All of these
2. The steady-state error of type-1,second order system to a unit ramp input is
   a. $2\xi\omega_n$ **b.** $\omega_n / 2\xi$
   c. $2\xi / \omega_n$ **d.** $2\omega_n / \xi$
3. As the type of the system increased
   a.more errors are eliminated **b.**more errors are introduced
   c.no effect on errors **d.**none of these
4. The roots of the characteristic equation are same as
   a.the poles of the closed loop transfer function **b.**zeros of the open loop transfer function
   c.poles of the open loop transfer function **d.**none of these
5. The root-locus always starts at the
   a.open loop poles **b.**open loop zeros
   c.closed loop poles **d.**closed loop zeros
6. For a stable system
   a.GM must be positive and PM can be positive or negative **b.**PM must be positive and GM can be positive or negative
   c.Both GM and PM must be positive **d.** one of them must be zero
7. A polar plot intersects the real axis at (-1+j0) point. The gain margin of the system is
   a. -1 dB **b.** 0 dB
   c. infinity dB **d.** can not be estimated

(b) Find the Transfer Function $X_1(s)/f(s)$ for the given Mechanical System shown in Fig. 1. **07**

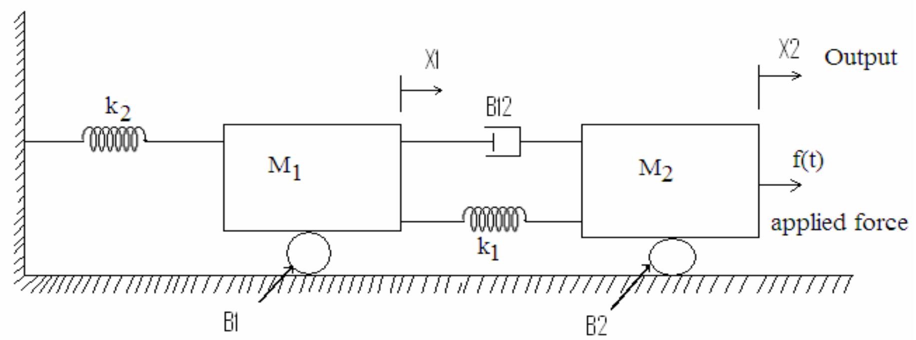

Fig.1

Q.2 **(a)** Derive the transfer-function for armature-controlled dc motor with load. Consider the motor velocity $\omega(s)$ as output variable and input voltage $E_a(s)$ as input variable for the transfer function. Also represent the same in the block diagram. **07**

(b) Using the block-diagram reduction techniques, simplify the diagram shown in Fig. 2. **07**

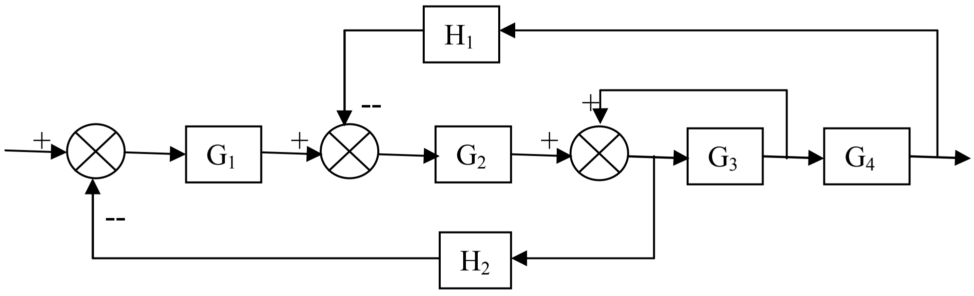

Fig. 2.

OR

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

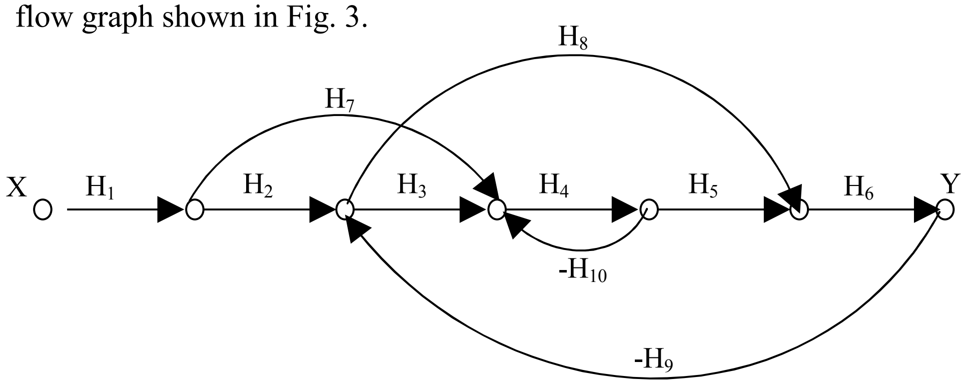

Fig. 3.

Q.3 **(a)** Determine the state model for the electrical network shown in Fig 4. Consider currents i_1, i_2 and capacitor voltage Vc as the state variables. The output variables are i_1 and i_2. **07**

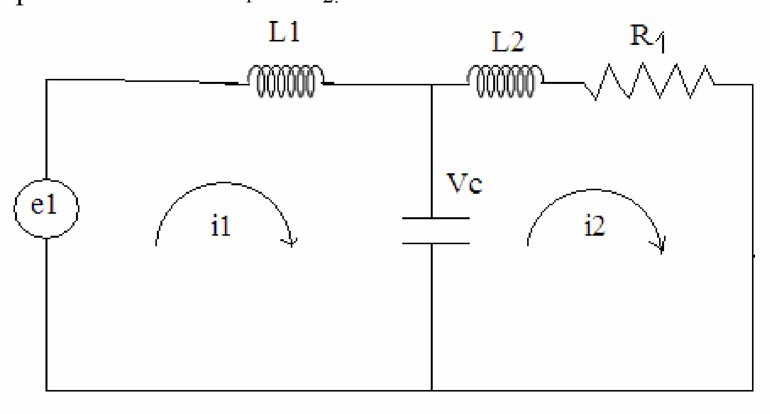

Fig. 4

(b) Derive the expressions for static error coefficients? And show that how the type of the system effects the steady state error? **07**

OR

Q.3 **(a)** Derive expression of output response, c(t), of second order unity feedback system subjected to a unit step input whose closed-loop transfer function is given by **07**

$$\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

a. Derive expression of c(t) for $\zeta=0$ and $\zeta=1$.
b. Derive expressions of (i) Rise time, tr (ii) Peak time, tp and (iii) Peak overshoot, Mp for the system.

(b) A unity feedback control system has the plant **07**

$$G(s) = \frac{K}{s(s+\sqrt{2K})}$$

a. Determine the percent overshoot and settling time (use 2% criterion) due to unit step input.
b. For what range of K is the settling time less than 1 second?

Q.4 **(a)** Expain the effects of the proportional, integral and derivative action on the closed loop system performance. **07**

(b) Consider the closed-loop system shown in Fig. 5. Determine the range of K for which the system is stable. **07**

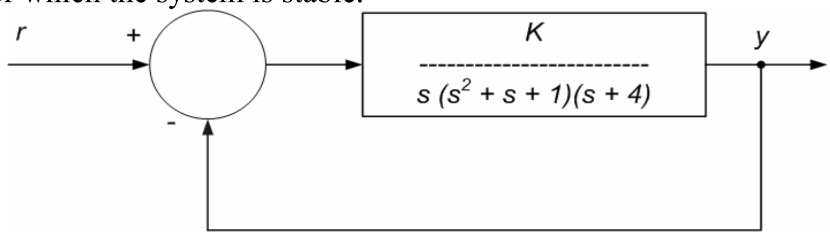

Fig. 5

OR

Q.4 **(a)** 1. Discuss the magnitude and phase angle conditions for drawing the root locus. **01**

2. A tape recorder has a speed control system so that H(s) = 1 with negative feedback, and **04**

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

i. Sketch the root locus for $K > 0$.
ii. Obtain the limiting value of gain K for stability and also the corresponding frequency.

(b) Draw only the rough sketches (without any calculations and procedure) of the Root-locus, Nyquist contour and Bode diagram for the given transfer functions. **09**

Sr. No.	Transfer Function	Root Locus	Nyquist Contour	Bode Diagram
1	$G(s) = \frac{K}{s\tau_1 + 1}$			
2	$G(s) = \frac{K}{s(s\tau_1 + 1)}$			
3	$G(s) = \frac{K}{(s\tau_1 + 1)(s\tau_2 + 1)}$			

Q.5 **(a)** Explain the principal of argument (mapping theorem) and Nyquist stability criterion for the closed loop system. **07**

(b) Sketch the Nyquist contour for the system given by the open loop transfer function **07**

$$G(s) = \frac{10}{s(s+1)(s+3)}$$

Infer the stability and determine the gain margin and phase margin along with the phase cross over frequency and gain cross over frequency.

OR

Q.5 **(a)** Sketch the bode plots for the open loop transfer function given by **07**

$$G(s) = \frac{100}{s(s+1)(s+5)}$$

and determine the gain margin and the phase margin. Is the system stable?

(b) Establish the co-relation between the Time domain specifications and Frequency domain specifications for the second order system. **07**

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