Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– IV(NEW) EXAMINATION – SUMMER 2015

Subject Code: 2142003 **Date:**30/**05/2015**

Subject Name: Control Theory

Time: 10:30am-1.00pm **Total Marks: 70**

Instructions:

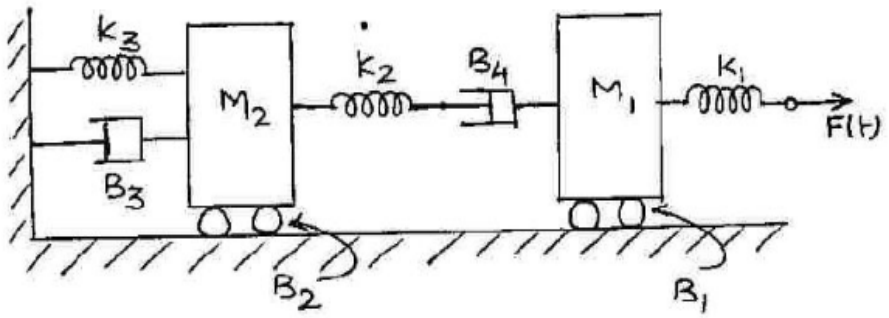
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Answer the following **07**

1)Define stable control system
2)Define LTI(Linear time invariant) system
3)Draw and explain the detailed block diagram of closed loop control system
4)Explain initial value and final value theorem
5)How transfer function is related to unit step response?
6)What are the advantages of state space analysis?
7)What is corner frequency in frequency response analysis.

(b) Write a short note on Gear Train and derive all the required equation. **07**

Q.2 **(a)** For the given mechanical system Write down differential equations, mechanical circuit diagram and obtain force-voltage analogy. **07**



(b) Obtain the overall transfer function C/R for the given block diagram **07**

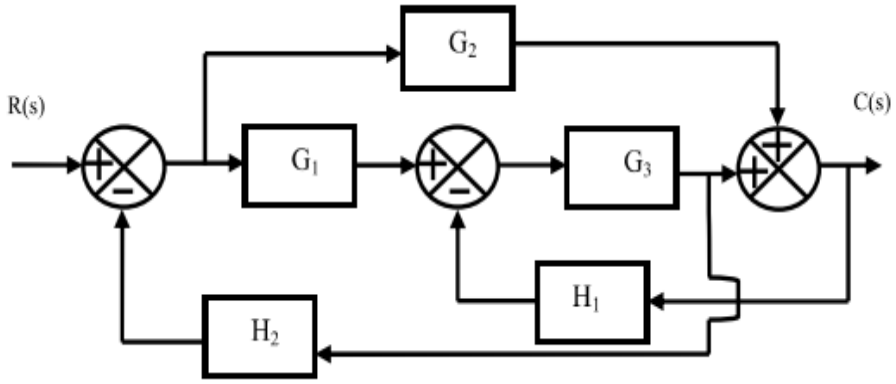


Fig.1

OR

(b) Draw signal flow graph for the above block diagram given in figure 1 and obtain the overall transfer function using Mason's gain formula **07**

Q.3 **(a)** Derive the transfer function for armature controlled D.C. motor and field controlled D.C. motor. **07**

(b) State space and out-put equation for the system defined by **07**

$$A = \begin{bmatrix} -5 & -1 \\ -3 & -1 \end{bmatrix} \quad B = \begin{bmatrix} 2 \\ 5 \end{bmatrix} \quad C = [1 \ \ 2] \quad D = [0]$$

Obtain the transfer function of the system.

OR

Q.3 **(a)** For the second order control system show the location of the poles in S-plane for the different value of damping ratio. Also show the time response of the same if unit step is provided as input. **07**

(b) A system has the following transfer function **07**

$$\frac{C(s)}{R(s)} = \frac{20}{s+10}$$

Determine its unit impulse, unit step and unit ramp response with zero initial conditions.

Q.4 **(a)** Derive the expression for static error coefficients. How these coefficients are useful in determining the steady state error? **07**

(b) A second order system is represented by the transfer function given below **07**

$$\frac{C(s)}{R(s)} = \frac{1}{Js^2 + Fs + K}$$

A step input of 10Nm is applied to the system and the test results are:

a) Maximum overshoot =6%
b) Time at peak overshoot = 1 sec
c) The steady value of the output is 0.5 radians

Determine the values of J,F,K

OR

Q.4 **(a)** Derive the expression for unit ramp response for second order control system. **07**

(b) 1) Check the stability of the given characteristic equations using R-H criterion. **07**

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

2) Transfer function of the system is given as

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

Find the range of K for stability.

Q.5 **(a)** Sketch the root locus for the given open loop transfer function and determine the stability. Also write the matlab code for the same. **14**

$$G(s)H(s) = \frac{k(s+0.1)}{s(s-0.2)(s^2+s+0.6)}$$

OR

Q.5 **(a)** Sketch the Bode plot and determine the gain margin and phase margin for the given unity feedback control system. **07**

$$G(s) = \frac{10}{s(s+1)(s+5)}$$

(b) Using Nyquist plot, comment on the stability of the following system. **07**

$$G(s)H(s) = \frac{2.2}{s(s+1)(s^2+2s+2)}$$

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