Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- IVth SEMESTER–EXAMINATION – MAY/JUNE- 2012

Subject code: 141701 **Date: 29/05/2012**

Subject Name: Control Theory

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.**
4. **Students can use scientific calculator.**

Q.1 **(a)** Write two brief short notes on open loop control systems and closed loop control systems with the help of neat block diagrams. Explain role of each of the blocks. Give some suitable real life examples of both types of systems. **07**

(b) Explain the concept of linearity and time invariance in the context of control systems. Give definition of transfer function and explain the same. State any three advantages of closed loop systems over open loop control systems. **07**

Q.2 **(a)** Sketch the root loci of unity feedback control system on a graph paper using a suitable scale, whose open-loop transfer function is given below. Determine the range of gain for stability and the point at which it crosses the imaginary axis. Determine the value of gain K at the breakaway point. **07**

$$\frac{K}{S(S+4)(S^2+4S+8)}$$

(b) Draw signal flow graph of the system, whose block diagram is shown in Fig.1. Obtain closed loop transfer function of the system using Mason's gain formula. **07**

OR

(b) Using the block diagram reduction techniques, find the closed loop transfer function of the system whose block diagram is given in Fig. 1. **07**

Q.3 **(a)** Write definitions of state and state variables. Explain the fact that for any system, the set of state variables are non-unique. Discuss the limitations of transfer functions and advantages of analysis of control systems using state space. **07**

(b) Write state equation and output equation for a generalized control system using matrices A, B, C and D. Write two different state equations for a mass-spring and damper system. Find eigenvalues of system matrix A in both cases. Comment on your result. Assume suitable symbols for constants of all three elements. **07**

OR

Q.3 **(a)** Draw sketches of three time responses of a second order system for a unit step input for under damped, critically damped and over damped systems. Give definitions of five performance indices with the help of sketch drawn for under damped system. **07**

(b) Explain how (i) Breakaway points (ii) the point at which root locus crosses imaginary axis and (iii) response of closed loop system at a given value of gain are found for a root locus of given system. Explain how at a given point on the root locus, the gain can be determined. **07**

Q.4 **(a)** Write two notions of stability and a brief note on stability of control systems. Draw sketches of impulse response of control system having different locations of poles to explain the concept of stability. **07**

(b) Describe effects of integral and derivative controls on the performance of control systems. Discuss steady state error constants. **07**

OR

Q.4 **(a)** Comment on the stability of a closed loop system whose open-loop transfer function is, as given below, using Nyquist stability criterion. Draw Nyquist contour and corresponding G(s)H(s) contour. **07**

$$\frac{10}{(1+0.1S)(1+0.5S)}$$

(b) Write a short note on thermal system, its modeling and analysis for two different inputs. **07**

Q.5 **(a)** (i) State whether the root locus tool is a frequency response or a time response tool. **01**

(ii) Compare root locus technique and Bode plots for control system analysis purpose. Explain how root locus technique is more difficult than the Bode plots. **03**

(iii) Explain the frequency response, state its applications with possible limitations. **03**

(b) Explain constant-M circles and constant-N circles by deriving related expressions. Explain how resonant peak can be obtained. **07**

OR

Q.5 **(a)** Sketch Bode plots of a unity feedback control system having open-loop transfer function as given below. The magnitude plot of this function should be an exact one and not an approximation. **09**

$$G(S) = \frac{64(S+2)}{S(S+0.5)(S^2+3.2S+64)}$$

(b) Draw and explain Nyquist contour. Write definition and discuss the Nyquist stability criterion. **05**

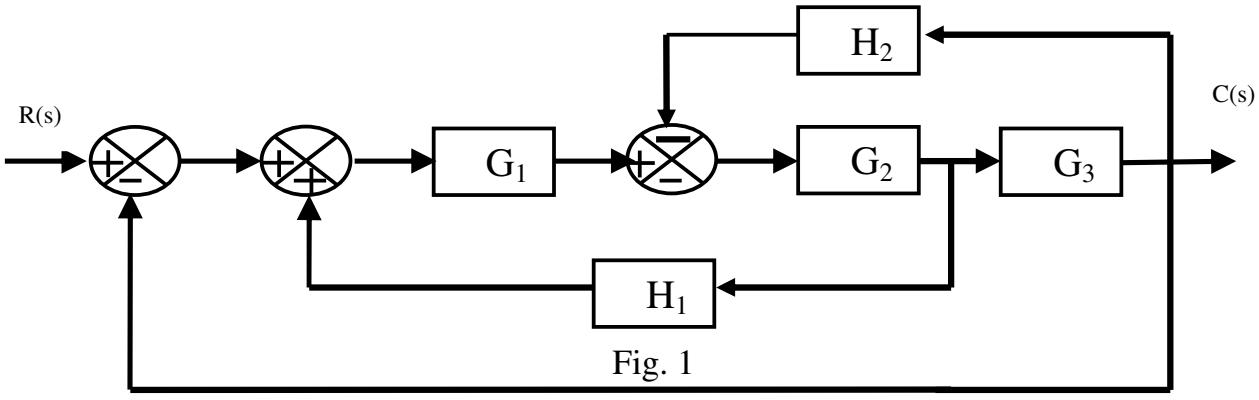

Fig. 1