Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV • EXAMINATION – WINTER 2013

Subject Code: 141701 Date: 26-12-2013

Subject Name: Control Theory

Time: 02:30 pm to 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) Find-out transfer function for Signal flow diagram as shown in Figure-1, using Mason's gains Formula. 07

(b) Using the block diagram reduction techniques, evaluate the closed loop transfer function of the system as per block diagram given in Figure-2 07

Q.2 (a) Explain the advantages of state space approach over classical methods and obtain state variable equation 07

$\dot{X} = AX + BU$ *And* $Y = CX + DU$ Also draw the block diagram.

(b) State and explicate Nyquist Stability criteria. Make clear about phase margin and gain margin using Nyquist plot. 07

OR

(b) Define Following Terms 07

(1) Transfer Function (2) State (3) Self Loop (4) Source Node

(5) Rise Time (6) Settling Time (7) Peak Time

Q.3 (a) Close loop transfer function of control system is given by 07

$\frac{C(s)}{R(s)} = \frac{K}{S^4 + 6S^3 + 30S^2 + 60S + K}$ (1) Determine the range of K must be lie for the system to be stable. (2) What should be upper limit of K is all the close loop pole are required to be the left side of the line ($\sigma = -1$).

(b) Explain the various rules for construction of root locus. 07

OR

Q.3 (a) Draw the approximate root-locus diagram for close loop system whose transfer function is given by $G(s)H(s) = \frac{K}{S(S+5)(S+10)}$ 07

(b) Define and explain following terms with respect to frequency response 07

(i) Gain Margin (ii) Phase Margin (iii) Gain cross-over frequency

(iv)Phase cross-over Frequency

Q.4 (a) Derive expression of response, c(t), of second order unity feedback system whose closed-loop transfer function is given below, for a unit step input as a function of time t and damping ratio ζ. Derive expression of c(t) for ζ=0 and ζ=1. 07

$T_s = \frac{C(s)}{R(s)} = \frac{\omega_n^{\ 2}}{S^2 + 2\xi\omega_n + \omega_n^{\ 2}}$

(b) Derive expressions of (i) Rise time, t_r (ii) Peak time, t_p and (iii) Peak overshoot, M_p for the system of above Question 4(a). 07

OR

Q.4 (a) Draw the equivalent mechanical system for the given system as per figure-3. Hence write a set of equilibrium equations and obtain electrical analogous circuit using (1) F-I analogy (2) F-V analogy 07

(b) Explain Liquid Level system and Derive Transfer Function of Liquid Level system with Interaction. 07

Q.5 (a) Explain Standard Test signals 07

(b) Derive the transfer function for armature controlled DC motor. 07

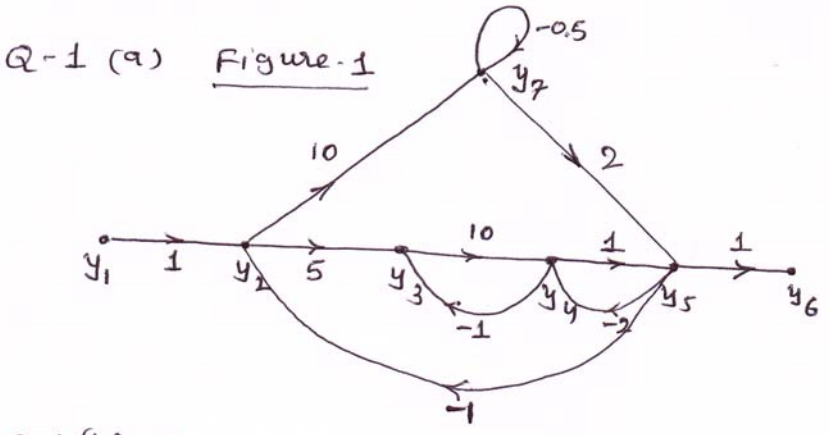
OR

Q.5 (a) For a particular unity feedback system, 07

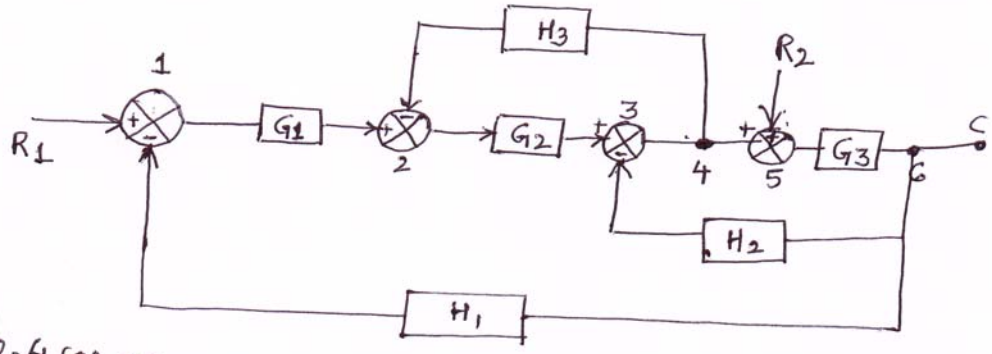
$G(s) = \dfrac{242(S+5)}{S(S+1)(S^2+5S+121)}$. Sketch Bode plot. Find ω_{gc}, ω_{pc} , $G.M., P.M.$ comment on stability.

(b) What is polar plot? Explain polar plot for Type-0, 1, 2 systems. 07

Q-1 (a) Figure-1



Q-1 (b) Figure-2



Q-4 (a) OR Figure-3