Seat No.: _

Enrolment No.__

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER-IV(New) • EXAMINATION - WINTER 2016

Subject Code:2142003

Date:21/11/2016

14

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 Do as directed. (short questions)

- (1) State the difference between open-loop *vs* close-loop control system.
- (2) What is force-voltage analogous system? Which are the analogous quantities according to this method?
- (3) Define pole, zero and order of a control system.
- (4) List out the advantages of state space analysis over the conventional transfer function method.
- (5) Write the Mason's gain formula.
- (6) The closed loop transfer function of a second order system is given by $\frac{4}{s^2+2s+4}$. Determine the damping ratio and natural frequency of oscillation.
- (7) Explain, How the roots of characteristic equation are related to stability?
- (8) Draw the time response of first order system with step input.
- (9) Define rise time for underdamped system.
- (10) Define absolute stability and relative stability.
- (11) What is bode plot? With necessary diagram explain the gain margin and phase margin.
- (12) State the Nyquist stability criterion?
- (13) How will you find the gain K at a point on root locus?
- (14) What is the effect on system performance, when a Proportional Integral (PI) controller is introduced in a system?
- Q.2 (a) For the given mechanical translation system (Fig. 1). Write down differential equations, represents in Force-Voltage analogy, and find out $X_1(s)/F(s)$.
 - (b) A linear feedback control system has the block diagram shown in Fig. 2. Using 07 block diagram reduction rules, obtain overall transfer function C(s)/R(s).

OR

- (b) For the signal flow graph shown in Fig. 3, using Masson's gain formula 07 determine the overall transmission C/R.
- Q.3 (a) Draw the liquid level system and explain the concept of resistance and 03 capacitance of the system.
 - (b) Derive the transfer function of an armature controlled DC motor. 04
 - (c) For a closed-loop control system whose transfer function is given as, 07

$$\frac{C(s)}{R(s)} = \frac{4}{s(s+1)(s+3)}$$

Obtain the state equations and give block diagram representation for state model.

OR

| | | OR | |
|----------|------------|--|----|
| Q.3 | (a) | Using suitable diagram derive the transfer function of Thermometer placed in water bath as a Thermal system. | 03 |
| | (b) | Sketch and explain, how damping ratio affects the time response of a second order system? | 04 |
| | (c) | A unity feedback system is characterized by an open loop transfer function | 07 |
| | | $G(s) = \frac{K}{s(s+10)}$. Determine the gain K so that the system will have a damping | |
| | | ratio of 0.5. For this value of K, determine rise time, settling time, time to peak | |
| | | overshoot, and peak overshoot for unit step input. | |
| Q.4 | (a) | Define Routh's stability criterion. | 03 |
| - | (b) | Construct Routh array and determine the stability of the system whose | 04 |
| | | characteristic equation is $s^{6} + 3s^{5} + 5s^{4} + 9s^{3} + 8s^{2} + 6s + 4 = 0$. | |
| | (c) | Investigate the stability of a closed-loop system whose open-loop transfer | 07 |
| | (-) | | |
| | | function is $G(s)H(s) = \frac{1}{s(s+1)}$ using Nyquist stability criterion. | |
| | | OR | |
| Q.4 | (a) | How to determine gain margin and phase margin from the polar plot or | 07 |
| | | Nyquist plot? | |
| | (b) | Given $G(s)H(s) = \frac{12}{s(s+1)(s+2)}$. Draw the polar plot and determine its gain | 07 |
| | | margin and phase margin. System is stable or not? | |
| Q.5 | (a) | Define and explain following terms with respect to root locus | 07 |
| C | | (i) Centroid (iv) Breakaway point | |
| | | (ii) Asymptote (v) Breakin point | |
| | | (iii) Dominant pole (vi) Angle of departure (vii) Angle of arrival | |
| | (b) | Sketch the root locus of the system whose open-loop transfer function is | 07 |
| | | $G(s)H(s) = \frac{K}{s(s^2 + 2s + 2)}$. Comment on stability. | |
| | | OR | |
| Q.5 | (a) | Define and explain following terms with respect to Bode plot | 07 |
| X | () | (i) Gain crossover frequency (iii) Gain Margin | 01 |
| | | (ii) Phase crossover frequency (iv) Phase margin | |
| | (b) | | 07 |
| | ~) | Draw the Bode plot for a system having $G(s)H(s) = \frac{80}{s(s+2)(s+20)}$. | |
| | | Find out Gain margin, Phase margin, Gain crossover frequency and phase | |
| | | | |

cross over frequency. Comment on the stability.



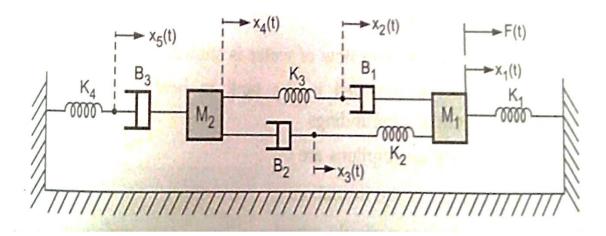


Fig. 2 (For Q.2 (b))

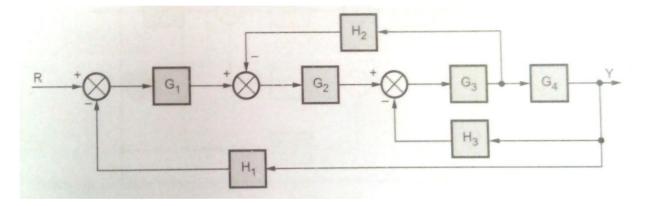


Fig. 3 (For Q.2 OR (b))

