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06ES43

Fourth Semester B.E. Degree Examination, December 2012
Control Systems

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer FIVE full questions atleast TWO questions from each part.***
2. Semi –log sheets may be provided for Q7(b).

PART – A

1 a. Define 'control system'. Draw the basic block diagram of a control loop giving all the relevant details. **(04 Marks)**

b. Distinguish briefly between open loop and closed loop systems ; linear and non – linear systems ; and time –variant and time – invariant systems. **(06 Marks)**

c. For the mechanical translational system shown in Fig. Q1(c), draw the mechanical network ; write the mechanical and electrical differential equation and obtain the force – voltage analogy. **(10 Marks)**

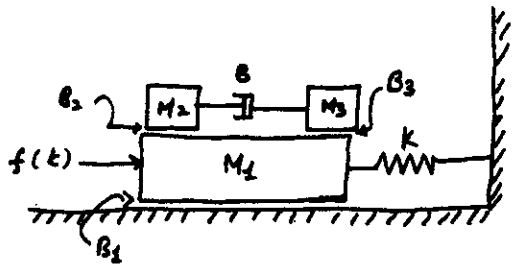

Fig. Q1(c)

2 a. Using block diagram reduction technique, find the overall transform function of the system represented by the block diagram shown in Fig. Q2(a) **(10 Marks)**

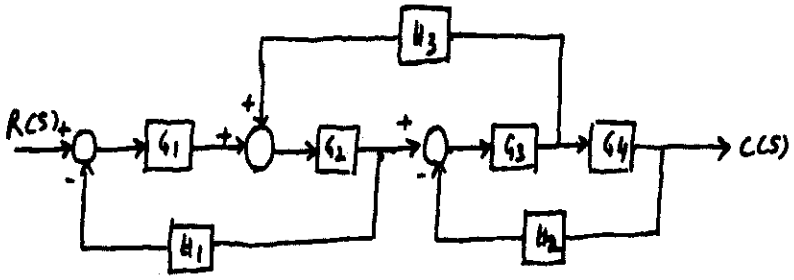

Fig. Q2(a)

b. Using Mason's gain formula, obtain x_8/x_1 for the signal flow graph shown in Fig. Q2(b). **(10 Marks)**

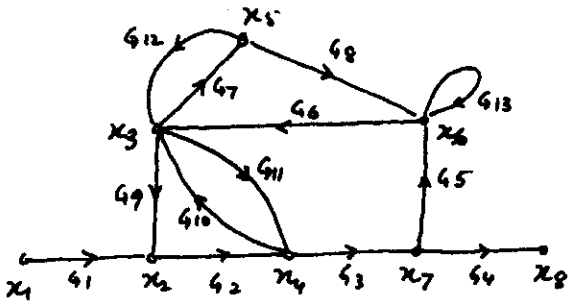

Fig. Q2(b)

3 a. Draw the typical time domain in response of an underdamped second order system to a unit step input and define the various time domain performance parameters indicating the same on the diagram. **(10 Marks)**

b. Fig. Q3(b) shows a system employing proportional plus error-rate control. Determent the value of the error- rate factor k_e so that the damping ratio is 0.5. Determine the values of settling time k_s, maximum overshoot M_p, and steady state error e_{ss} for a unit ramp input with and without error – rate control. Comment upon the effect of error – rate control on system dynamics. **(10 Marks)**

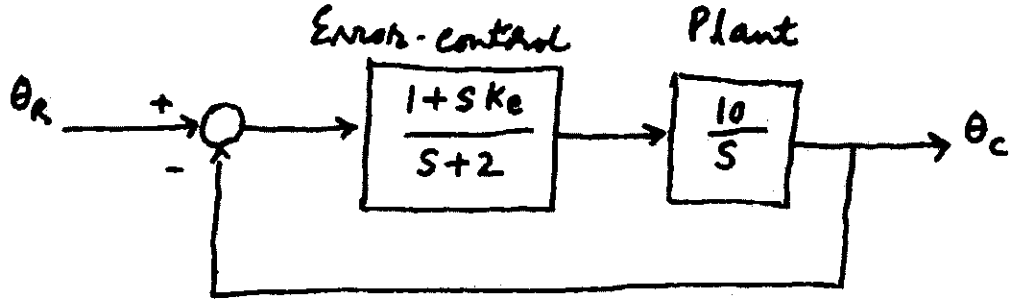

Fig. Q3(b)

4 a. Explain BIBO and Zero – input stability. **(04 Marks)**

b. What are the benefits of feedback in a control system? **(04 Marks)**

c. Determine the range of values of k ($k \geq 0$) such that the characteristic equation

$$s^3 + 3(k + 1)\, s^2 + (7k + 5)\, s + (4k + 7) = 0$$

has roots more negative than s = -1. **(12 Marks)**

PART – B

5 a. Define 'Root – locus'. Explain how a root – locus helps in stapling the time domain response of a control system. **(08 Marks)**

b. Draw the root – locus fo the system having

$$G(s)H(s) = \frac{k}{s(S+4)(s^2+8s+32)}$$

As k is varied from 0 to ∞. Show all the steps involved in drawing the root – locus and also mention all the details on the diagram. Comment on stability of the system. **(12 Marks)**

6 a. Explain the application of Cauchy's theorem (principle of arrangement) used in Nyquist stability criterion. **(08 Marks)**

b. Construct Nyquist plot for a feedback control system whose loop transfer function is given by

$$G(s)sH(s) = \frac{5}{s(1-s)}$$

Comment on the stability of open loop and closed loop system. **(12 Marks)**

7 a. Derive the expression for resonance peak (M_r) for a second order system whose closed loop transfer function is

$$\frac{C(s)}{R(s)} = \frac{w_n^2}{s^2 + 2sw_n s + w_n^2}.$$ **(08 Marks)**

b. A system has the loop transfer function

$$G(s)H(s) = \frac{k}{s(1+s)(1+0.1s)(1+0.01s)}$$

i) Find the gain margin and phase margin for k = 1

ii) Determine the values of k so that the gain margin is +10 dBs and phase margin is +25°. **(12 Marks)**

8 a. Draw a comparison between the transfer function method of analysis and state space variables approach. **(06 Marks)**

b. Write the advantages and disadvantages of state space representation of transfer function using phase variables. **(06 Marks)**

c. Obtain the Jordan canonical form of presentation for the transfer function

$$G(s) = \frac{s+3}{s^3 + 9x^2 + 24s + 20}$$

Also draw the corresponding signal flow graph. **(08 Marks)**

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