USN | | | | | | | | | | 06ES43

Fourth Semester B.E. Degree Examination, June 2012

Control Systems

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. i) Describe in a simplified way, the components and variables of the biological control system involved in walking in a prescribed direction.
ii) Why is walking a closed loop operation?
iii) Under what conditions would the human walking apparatus become an open-loop system?
iv) Draw a block diagram assuming the person has a normal vision. **(08 Marks)**

b. What are the variables and elements of translational motion?
For the mechanical system shown in Fig.Q1(b),
i) Write the differential equations of performance.
ii) Draw and write loop and nodal equations based on F-V and F-I analogous networks.

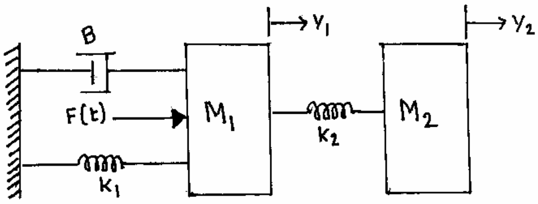

Fig.Q1(b) **(12 Marks)**

2 a. Find the closed loop transfer function of the system shown in Fig.Q2(a). **(10 Marks)**

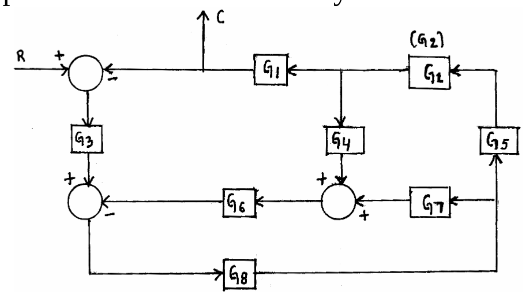

Fig.Q2(a)

b. For the signal flow graph shown in Fig.Q2(b), find $\frac{X_8}{X_1}$, using Mason's gain formula.

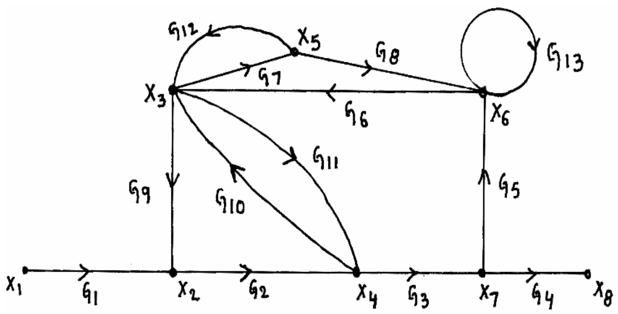

Fig.Q2(b) **(10 Marks)**

3 a. For a spring, mass, damper system shown in Fig.Q3(a)(i), an experiment was conducted by applying a force of 2 Newtons to the mass. The response X(t) was recorded using an X-Y plotter and the experimental result is as shown in Fig.Q3(a)(ii). Find the values of M, K and B. **(12 Marks)**

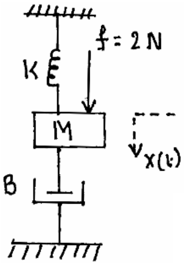

Fig.Q3(a)(i)

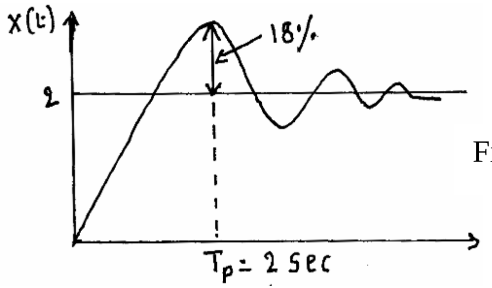

Fig.Q3(a)(ii)

b. Find K_p, K_v, K_a for the following unity feedback system $G(s) = \frac{100}{s^2(s+2)(s+5)}$.

Also determine the steady state error when the input is $r(t) = 1 + t + 2t^2$. **(08 Marks)**

4 a. Define: i) Marginally stable system; ii) Absolutely stable system; iii) Conditionally stable systems. **(06 Marks)**

b. Investigate the stability of the system represented by $s^6 + s^5 - 2s^4 - 3s^3 - 7s^2 - 4s - 4 = 0$, using R-H criterion. Ascertain the roots and indicate on S plan. **(08 Marks)**

c. The open loop transfer function of a unity feedback control system is given by,

$$g(s) = \frac{e^{-ST}}{s(s+2)}.$$

Investigate the stability. If stable or unstable, find the condition for T? **(06 Marks)**

PART – B

5 The open loop transfer function of negative feedback system is given by

$$G(s)H(s) = \frac{K(s+1)}{s(s-1)(s^2+4s+16)}.$$

Sketch the complete root locus with all pertinent details. **(20 Marks)**

6 a. Give step by step procedure to solve Nyquist criterion problem. **(06 Marks)**

b. For a certain control system $G(s)H(s) = \frac{K}{s(s+2)(s+10)}$. Sketch the Nyquist plot and hence calculate the range of values of K for stability. **(14 Marks)**

7 a. What are the various frequency response specifications? Define gain cross over frequency and phase cross over frequency. **(06 Marks)**

b. Sketch the Bode plot for the open loop transfer function for unity feedback control system and assess the stability, $G(s) = \frac{50}{(s+1)(s+2)}$. **(14 Marks)**

8 a. State the advantages of state variable analysis. **(04 Marks)**

b. Define the terms: i) state, ii) State variables. **(04 Marks)**

c. Obtain the time response of the system given: $\dot{X} = AX$, where $A = \begin{bmatrix} 0 & 1 \\ -2 & 0 \end{bmatrix}$;

given $X(t) = [1 \quad 1]^T$ and $Y = [1 \quad -1] \begin{bmatrix} X_1 \\ X_2 \end{bmatrix}$ **(12 Marks)**

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