Fourth Semester B.E. Degree Examination, June/July 2015

Control Systems

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. With the help of neat block diagram, define open loop and closed loop control system. **(04 Marks)**

b. For a mechanical system shown in Fig.Q1(b) obtain force voltage analogous electrical network. **(08 Marks)**

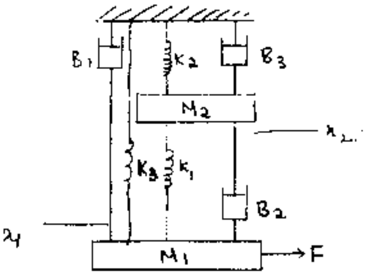

Fig.Q1(b)

c. Draw the electrical network based on torque current analogy and give all the performance equation for the Fig.Q1(c). **(08 Marks)**

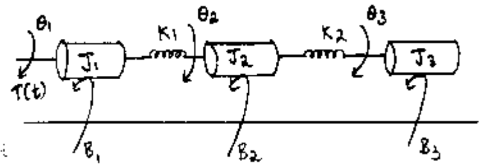

Fig.Q1(c)

2 a. Define the following terms related to signal flow graph with a neat schematic :
i) Forward path ii) Feedback loop iii) Self loop iv) Source node. **(04 Marks)**

b. Obtain the transfer function for the block diagram, shown in Fig .Q2(b). Using :
i) Block diagram reduction technique ii) Mason's gain formula. **(08 Marks)**

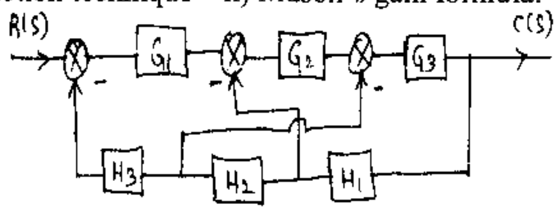

Fig.Q2(b)

c. For the signal flow graph shown in Fig. Q2(c), find the overall transfer function by :
i) Block diagram reduction technique
ii) Verify the result by mason's gain formula. **(08 Marks)**

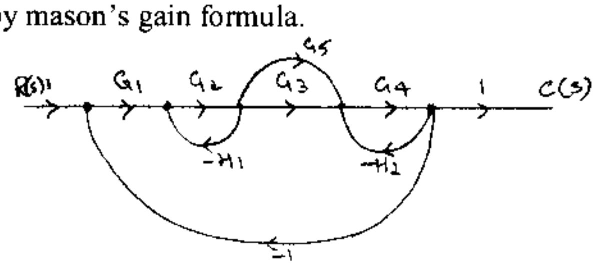

Fig.Q2(c)

3 a. Define and derive the expression for : i) Rise time ii) Peak overshoot of an under-damped second order control system subjected to step input. **(06 Marks)**

b. For a unit feedback control system with : $G(s) = \frac{10(s+2)}{s^2(s+1)}$, Find : i) The static error coefficients ii) Steady state error when the input is $R(s) = \frac{3}{s} - \frac{2}{s^2} + \frac{1}{3s^3}$. **(06 Marks)**

c. A system is given by differential equation $\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 8y = 8x$, where y = output and x = input. Determine : i) Peak overshoot ii) Settling time iii) Peak time for unit step input. **(08 Marks)**

4 a. Explain Routh – Hurwitz criterion for determining the stability of the system and mention its limitations. **(06 Marks)**

b. For a system $s^4 + 22s^3 + 10s^2 + s + k = 0$, find K_{mar} and ω at K_{mar}. **(06 Marks)**

c. Determine the value of 'k' and 'b' so that the system whose open loop transfer function is :

$G(s) = \frac{k(s+1)}{s^3 + bs^2 + 3s + 1}$ oscillates at a frequency of oscillations of 2 rad/sec. **(08 Marks)**

PART – B

5 a. For a unity feedback system, the open loop transfer function is given by:

$$G(s) = \frac{K}{s(s+2)(s^2+6s+25)}$$

i) Sketch the root locus for $0 \le k \le \infty$ ii) At what value of 'k' the system becomes unstable iii) At this point of instability, determine the frequency of oscillations of the system. **(15 Marks)**

b. Consider the system with $G(s)H(s) = \frac{k}{s(s+2)(s+4)}$, find whether s = -0.75 is point on root locus or not using angle condition. **(05 Marks)**

6 a. Explain the procedure for investigating the stability using Nyquist criterion. **(05 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. **(15 Marks)**

7 a. Sketch the bode plot for the open loop transfer function :

$G(s)H(s) = \frac{k(1+0.2s)(1+0.025s)}{s^3(1+0.001s)(1+0.005s)}$, Find the range of 'k' for closed loop stability. **(14 Marks)**

b. Define the following as applied to bode plots :
i) Gain margin ii) Phase margin iii) Gain and phase cross over frequency. **(06 Marks)**

8 a. Define the following terms : i) State ii) State variable iii) State space iv) State transition. **(04 Marks)**

b. A system is described by the differential equation, $\frac{d^3y}{dt^3} + \frac{3d^2y}{dt^2} + \frac{17dy}{dt} + 5y = 10u(t)$, where 'y' is the output and 'u' is input to the system. Determine the state space representation of the system. **(06 Marks)**

c. Obtain the state equations for the electrical network shown in Fig. Q8(c). **(10 Marks)**

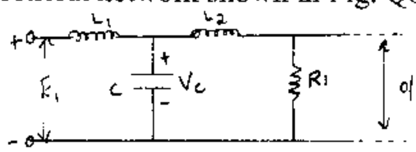

Fig.Q8(c)

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