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Fourth Semester B.E. Degree Examination, December 2011
Control Systems

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Distinguish between open loop and closed loop control system. **(04 Marks)**

b. For the system shown in Fig.Q.1(b), find the transfer function $G(S) = \frac{\theta_2(s)}{T(s)}$. Consider $J_1 = 1$ kgm^2, $K_1 = 1$ Nm/rad, $K_2 = 1$ Nm/rad. $B_1 = 1$Nm/rad/sec, $B_2 = 1$ Nm/rad/sec. **(06 Marks)**

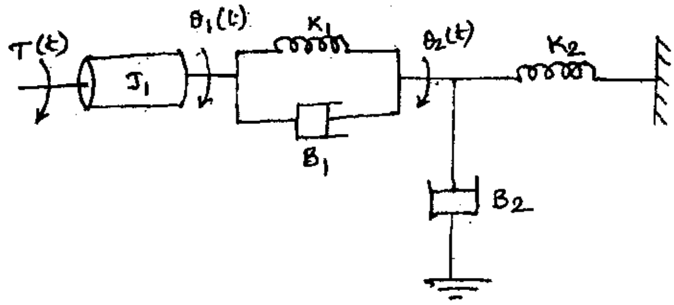

Fig.Q.1(b)

c. Draw the mechanical network for the system shown in Fig.Q.1(c). Write the equations of performance and draw its analogous circuit based on force voltage analogy. **(10 Marks)**

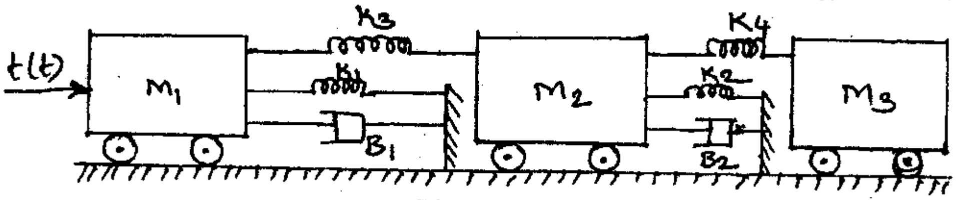

Fig.Q.1(c)

2 a. Derive an expression for the closed loop transfer function of a negative feed back system. **(04 Marks)**

b. Find the overall transfer function $\frac{C(s)}{R(s)}$ using block diagram reduction technique for the system shown in Fig.Q.2(b). **(08 Marks)**

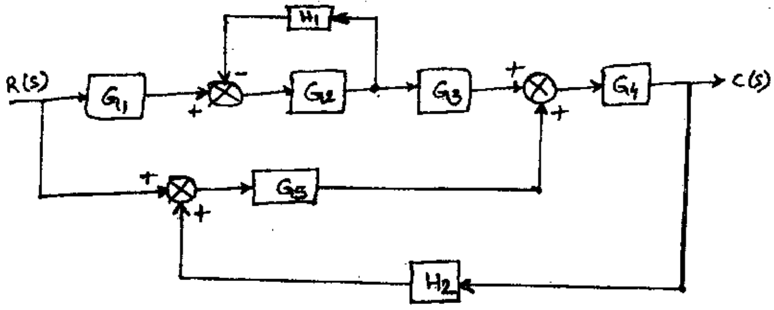

Fig.Q.2(b).

c. Find $\frac{C}{R}$ using Mason's gain formula for the signal flow graph shown in the Fig.Q.2(c). **(08 Marks)**

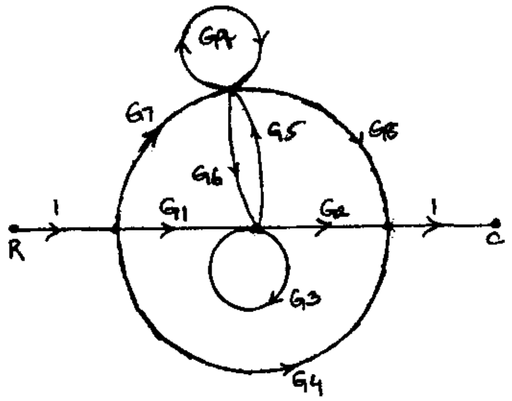

Fig.Q.2(c).

3 a. Considering the response of a second order under damped system to a step input, derive the following : i) Peak time (t_p) ; ii) Rise time (t_r) ; iii) Maximum overshoot (M_p). **(10 Marks)**

b. For the negative feed back control system shown in Fig.Q.3(b). Find :
   i) Percentage overshoot for the unit step input
   ii) Settling time for a unit step input
   iii) Steady state error for the input defined by the polynomial $r(t) = 2 + 4t + 6t^2,\ t \geq 0$. **(10 Marks)**

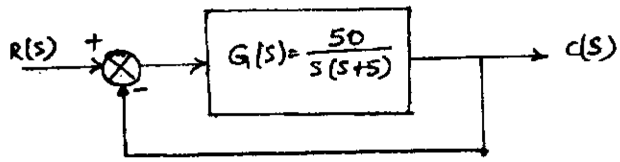

Fig.Q.3(b).

4 a. Explain R-H criterion for determining the stability of a system and mention its limitations. **(06 Marks)**

b. A unity feed back control system is descried by the characteristic equation
$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$
Test its stability and find frequency of oscillations. **(06 Marks)**

c. Determine the values of K and b, so that the system shown in Fig.Q.4(c) oscillates with a frequency of 2 rad/sec. **(08 Marks)**

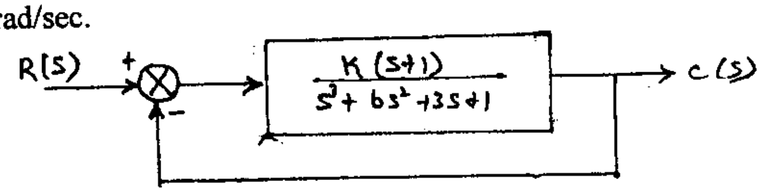

Fig.Q.4(c).

PART – B

5 a. Using angle criterion, prove that the complex part of the root loci for the open loop transfer function given by $G(s)H(s) = \frac{K(s+6)}{(s+2)(s+4)}$ is circular. What is its centre and radius? **(08 Marks)**

b. Sketch the root locus plot for a negative feed back control system whose open loop transfer function is given by $G(s)H(s) = \frac{k}{s(s+1)(s+2)(s+3)}$ for all values of K ranging from 0 to ∞. Find the value of K for closed loop stability. **(12 Marks)**

6 a. Find the gain margin and phase margin for the negative feedback control system having open loop TF $G(s)H(s) = \frac{6}{(s^2+2s+2)(s+2)}$. **(08 Marks)**

b. Using Nyquist stability criterion, investigate the stability of a negative feedback control system whose openloop TF is given by $G(s)H(s) = \frac{100}{(s+1)(s+2)(s+3)}$. Assume wg = 1.253 rad/sec wg = gain cross over frequency. **(12 Marks)**

7 a. Sketch the Bode – plot for the openloop TF $G(s)H(s) = \frac{k(1+0.2s)(1+0.025s)}{s^3(1+0.001s)(1+0.005s)}$. Find the range of K for closed loop stability. **(14 Marks)**

b. For the plot of the asymptotic magnitude (in db) versus frequency (log scale) shown in Fig.Q.7(b), find the associated transfer function. **(06 Marks)**

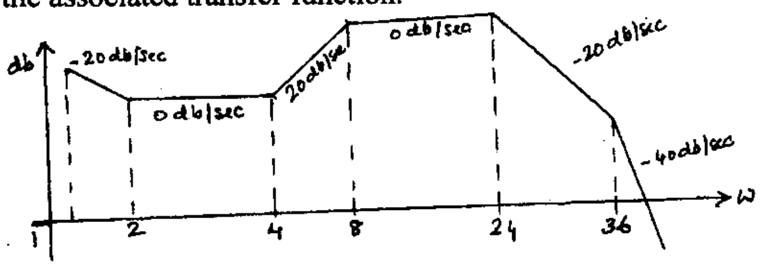

Fig.Q.7(b)

8 a. Define : i) State ; ii) State space and iii) State variables. **(06 Marks)**

b. Obtain the appropriate state model for a system represented by an electric circuit in Fig.Q.8(b). **(08 Marks)**

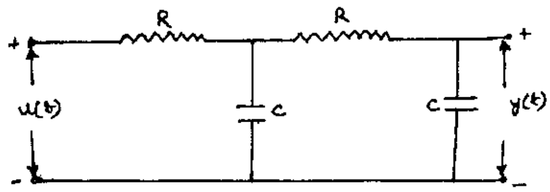

Fig.Q.8(b)

c. Represent the mechanical system shown in Fig.Q.8(c) by state space with X_2 as output. **(06 Marks)**

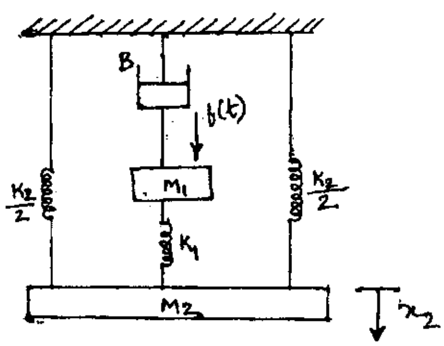

Fig.Q.8(c)

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