USN | | | | | | | | | | 10ES43

Fourth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Control Systems

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. A mechanical system is shown in the Fig.Q.1(a).
   i) Obtain the performance equations.
   ii) Draw the electrical analog based on force-current analogy. **(08 Marks)**

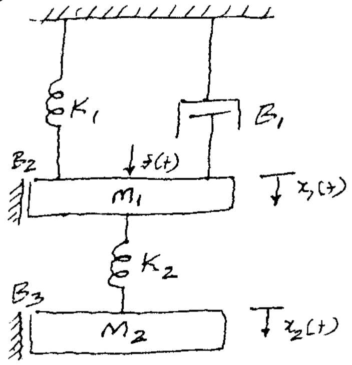

Fig.Q.1(a)

b. For the mechanical system shown in Fig.Q.1(b), draw the electrical network based on torque current analogy. Write the performance equations. **(08 Marks)**

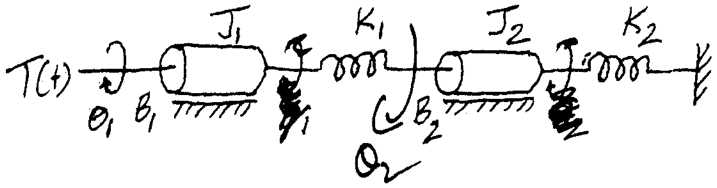

Fig.Q.1(b)

c. Write an explanatory note on gear trains. **(04 Marks)**

2 a. Define the term transfer function of a linear time invariant system. Derive the expression for the transfer function of a closed loop negative feedback system. **(06 Marks)**

b. For the block diagram shown in the Fig.Q.2(b), determine the overall transfer function using block diagram reduction rules. **(06 Marks)**

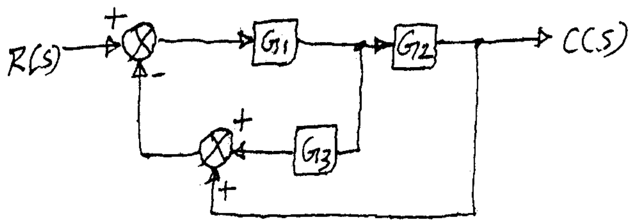

Fig.Q.2(b)

c. Consider the electrical circuit shown in Fig.Q.2(c). Find $\frac{V_0(s)}{V_i(s)}$ using Mason's gain formula. **(08 Marks)**

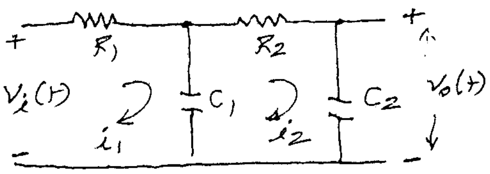

Fig.Q.2(c)

3 a. Define the following terms with respect to an underdamped second order system:
i) Peak time; ii) Settling time; iii) Steady state error. **(06 Marks)**

b. A unity feedback system is characterized by an open loop transfer function $G(s) = \frac{K}{s(s+10)}$.
Determine the gain K so that the system will have a damping ratio of 0.5. For this value of K, determine settling time, peak over shoot and time to peak overshoot for a unit step input. **(08 Marks)**

c. For a unity feedback system whose open loop transfer function is $G(s) = \frac{50}{(1+0.1s)(1+2s)}$.
Find the error constants K_p, K_v, K_a. **(06 Marks)**

4 a. State the Routh's stability criterion and mention its limitation. **(04 Marks)**

b. Consider the characteristic equation $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$. Using Routh's criterion, determine the stability of the system. **(08 Marks)**

c. The closed loop system shown in Fig.Q.4(c) has $G(s) = \frac{K(s+30)}{s(s+5)}$ and $H(s) = \frac{1}{(s+15)}$.
Find the range of K for which system is stable. **(08 Marks)**

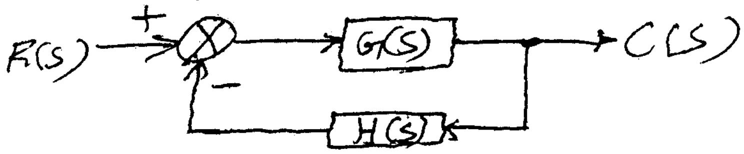

Fig.Q.4(c)

PART – B

5 a. Discuss the various rules for construction of root loci. **(08 Marks)**

b. A negative feedback control system is characterized by $G(s)H(s) = \frac{K}{s(s+1)(s+2)(s+3)}$.
Sketch the root locus plot for values of K ranging from 0 to ∞, Mark all the salient points on the root locus. **(12 Marks)**

6 a. Discuss the procedure to evaluate Gain margin and phase margin using Bode plots. **(06 Marks)**

b. Sketch the Bode plot for the transfer function $G(s) = \frac{Ks^2}{(1+0.2s)(1+0.02s)}$. Determine the system gain K for the gain cross over frequency to be 5 rad/sec. **(08 Marks)**

c. For the Bode magnitude asymptotic plot of Fig.Q.6(c), determine the transfer function in frequency domain. **(06 Marks)**

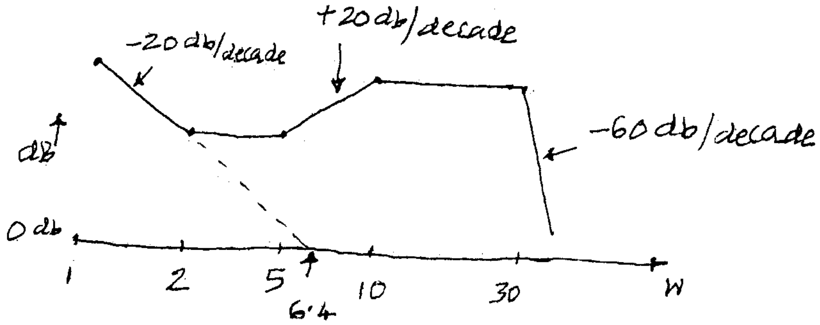

Fig.Q.6(c)

7 a. State the Nyquist stability criterion. **(06 Marks)**

b. Using the Nyquist stability criterion, investigate the stability of a closed loop system whose open loop transfer function is given by $G(s)H(s) = \frac{K}{(s+1)(s+2)}$. **(14 Marks)**

8 a. State the properties of state transition matrix. **(04 Marks)**

b. Represent the electrical circuit shown in Fig.Q.8(b) by a state model. **(08 Marks)**

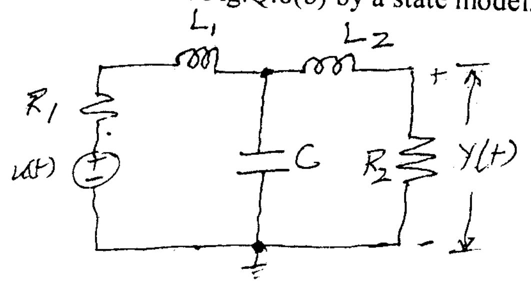

Fig.Q.8(b)

c. For the signal flow graph of Fig.Q.8(c) write the state and output equations: **(08 Marks)**

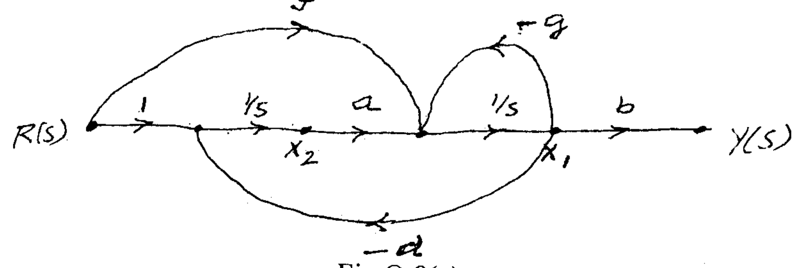

Fig.Q.8(c)

* * * * *