USN | | | | | | | | | | |

10ES43

Fourth Semester B.E. Degree Examination, June/July 2014
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. Explain with examples open loop and closed loop control systems. List merits and demerits of both. **(10 Marks)**

b. Draw the electrical network based on torque-current analogy give all the performance equation for the Fig.Q.1(b). **(10 Marks)**

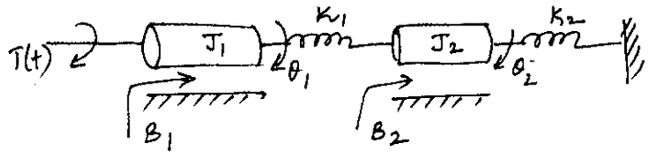

Fig.Q.1(b)

2 a. Obtain the T.F of the system using block diagram reduction method. **(10 Marks)**

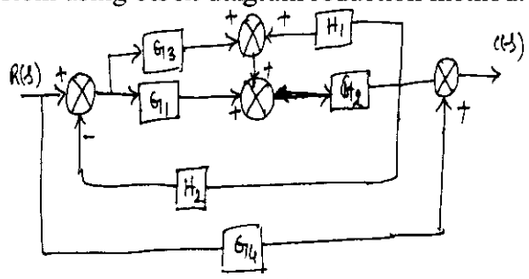

Fig.Q.2(a)

b. Obtain the transfer function using signal flow graph. By Mason's gain formula. **(10 Marks)**

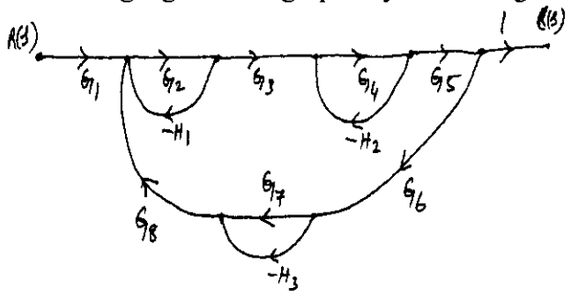

Fig.Q.2(b)

3 a. Draw the transient response characteristics of a control system to a unit step input and define the following: i) Delay time; ii) Rise time; iii) Peak time; iv) Maximum overshoot; v) Settling time. **(06 Marks)**

b. Derive the expressions for peak time t_p for a second order system for step input. **(04 Marks)**

c. The response of a servo mechanism is $c(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$ when subjected to a unit step input. Obtain an expression for closed loop transfer function. Determine the undamped natural frequency and damping ratio. **(04 Marks)**

d. The open loop transfer function of a unity feedback system is given by $G(s) = \frac{K}{S}(ST+1)$, where K and T are positive constant. By what factor should the amplifier, gain 'K' be reduced so that the peak, overshoot of unit step response of the system is reduced from 75% to 25%. **(06 Marks)**

4 a. Explain Routh-Hurwitz criterion in stability of a control system. **(04 Marks)**

b. The characteristics equation for certain feedback control systems are given below. Determine the system is stable or not and find the value of for a stable system $S^3 + 3ks^2 + (k+2)s + 4 = 0$. **(06 Marks)**

c. The open loop T.F. of a unity feedback system is given by

$$G(s) = \frac{k(s+3)}{s(s^2+2s+3)(s+5)(s+6)}$$

Find the value of 'K' of which the closed loop system is stable. **(06 Marks)**

d. What are the disadvantages of RH criterion on stability of control system? **(04 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 oscillation 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 and s = -1 + j4 is on the root locus or not using angle condition. **(05 Marks)**

6 a. Construct the Bode plots for a unity feedback control system having

$$G(s) = \frac{2000}{s(s+1)(s+100)}$$

from the Bode plots determine:

i) Gain cross over frequency.

ii) Phase cross over frequency.

iii) Gain margin.

iv) Phase margin.

Comment on stability. **(14 Marks)**

b. List the limitations of lead and lag compensations. **(06 Marks)**

7 a. The transfer function of a control system is given by $\frac{y(s)}{u(s)} = \frac{s^2+3s+4}{s^3+2s^2+3s+2}$ obtain a state model. **(10 Marks)**

b. State the properties of state transition matrix and derive them. **(10 Marks)**

8 a. Explain the procedure for investigating the stability using Nyquist criterion. **(08 Marks)**

b. Using Nyquist stability criterion, investigate the closed loop stability of a negative feedback control system whose open loop transfer function is given by

$G(s)H(s) = \frac{K(ST_a+1)}{S^3}$, $K, T_a > 0$. **(12 Marks)**

* * * * *