Time : 3 Hrs **Marks : 80**

Note:- (1) Q no. 1 is compulsory

(2) Solve any three questions from Q. No. 2 to Q.no. 6.

(3) Assume suitable data whenever necessary

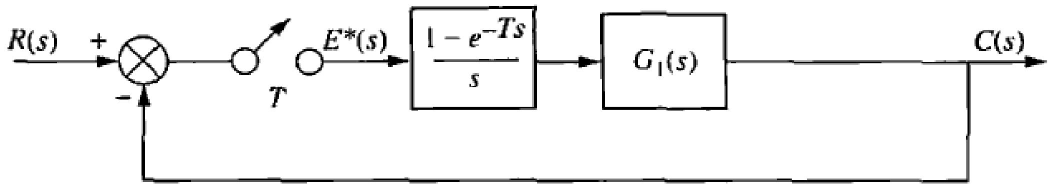
1 a) Distinguish between Cascade compensation and Feedback compensation with block diagram. (4)

1 b) Explain Ideal Integral compensator for improving Steady State Error. (4)

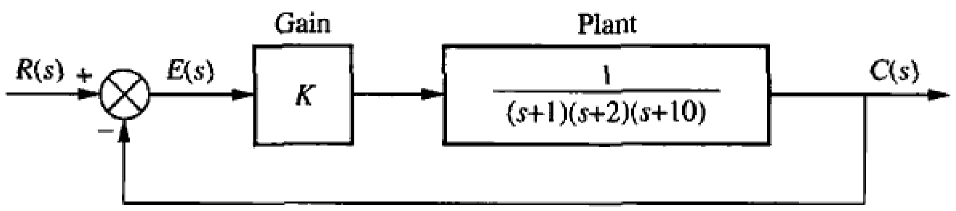
1 c) Explain the difference in design of Lag compensator and Lead Compensator. (4)

1 d) Derive Controllability of n^{th} order plant in state variable approach. (4)

1 e) For Step, Ramp and Parabolic inputs, find the steady-state error for the feedback control system shown in Figure if $G_1(s) = \frac{10}{S(S+1)}$ (4)



2 a) Design a Lag compensator for the system given operating with the damping ratio 0.174 which reduces the Steady State error to zero for a step input.



(10)

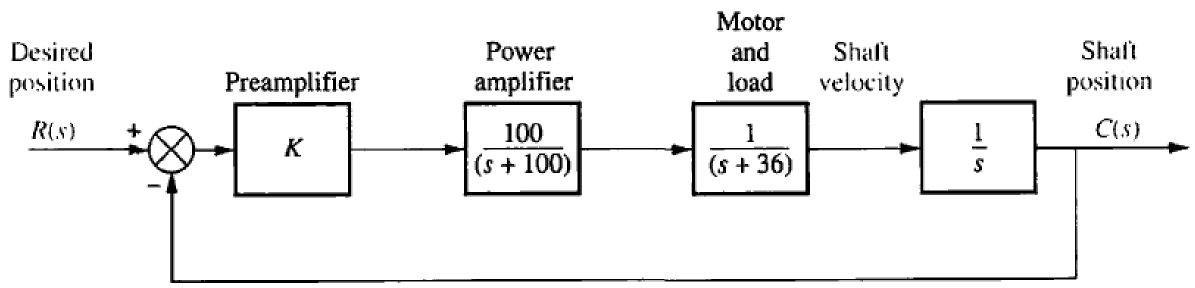
2 b) For the unity feedback system with the forward transfer function,

$$G(s) = \frac{K}{s(s+50)(s+120)}$$

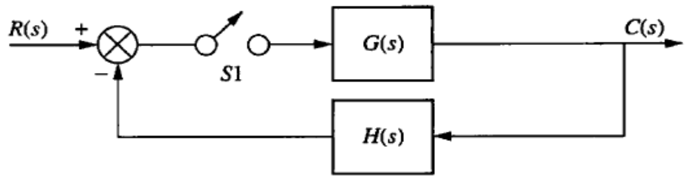
Use frequency response techniques to find out the Gain K to yield the close loop step response with 20 % overshoot.

(10)

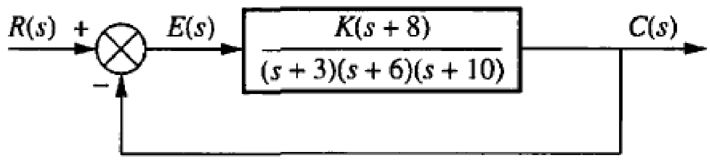
3 a) Design a lead compensator to yield the 20 % overshoot and $K_v = 40$ with the peak time of 0.1 second . (10)



3 b) Find the Z transform for the system given in figure (10)



4 a) Design a PID controller so that system can operate with the peak time that is two third that of uncompensated system at 20 % overshoot and with zero steady state error for the step input. (10)



4 b) Determine whether the system is controllable (10)

$$\dot{\mathbf{x}} = \mathbf{A}\mathbf{x} + \mathbf{B}u = \begin{bmatrix} -1 & 1 & 2 \\ 0 & -1 & 5 \\ 0 & 3 & -4 \end{bmatrix} \mathbf{x} + \begin{bmatrix} 2 \\ 1 \\ 1 \end{bmatrix} u$$

5 a) A unity feedback system with forward transfer function is given by (10)

$$G(s) = \frac{K}{S(S+7)}$$

is operating with a closed loop response that has 20 % overshoot. Do the following

i)Evaluate the settling time

ii)Evaluate the steady state error for the ramp input.

5b) Find the sampled transfer function for the function given (10)

$$F(z) = \frac{0.5\,z}{(z-0.5)(z-0.7)}$$

6 a) Design an observer for the plant (10)

$$G(s) = \frac{1}{(S+1)(S+2)(S+5)}$$

Which is represented in cascade form. The closed loop perfoemnce of the observer is governed by the chateristics polynomail as $S^3+120\,S^2+2500\,S+50{,}000$.

6 b) Develop the flow chart for digital compensator defined by (10)

$$G_c(z) = \frac{X(z)}{E(z)} = \frac{z+0.5}{(z^2-0.5z+0.7)}$$

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