1T00836 - T.E.(Electiral Engineering)(SEM-VI)(Choice Base Credit Grading System) (R-20-21) (C Scheme) / 89303 - Control System Design

QP CODE: 10014514 DATE: 13/12/2022

Duration: 3 Hours **Marks: 80**

Note:
1. Q.no. 1 is compulsory.
2. Answer any three questions from Q. No. 2 to Q. No. 6.
3. Write in legible handwriting.
4. Make any suitable assumptions wherever required.
5. Must make suitable supporting diagrams wherever desired.
6. Figure to the right indicates marks.

Q1 Each question carries five marks 20

a. Draw the bode plot of a typical lag compensator. Why it is called as a lag compensator?

b. Where a pole should be placed on z-plane to drive the steady state error of a sampled system to zero?

c. Where is the region of stability on the z-plane? Compare that with the stability region in s-plane.

d. Under what conditions would you use an observer in your state space design? Which plant representation lends itself to easier design of an observer? Why?

Q2 a. Draw the implementation for the digital compensator defined by $Gc(z)=\frac{(z+0.5)}{z^2-0.5z+0.7}$ 05

b. Given the following open-loop plant: 15

$G(s) = \frac{20(s+2)}{s(s+5)(s+7)}$ Design a controller to yield a 10% overshoot and a settling time of 2 seconds by assuming that the plant is represented in the parallel form.

Q3 a. Use frequency response methods to design a lead compensator for a unity feedback system where $G(s)=\frac{K(s+7)}{s(s+5)(s+15)}$ and the following specifications are to be met: percent overshoot=15%, Settling time=0.1sec, and Kv=1000. 10

b. Given the unity feedback system with $G(s)=\frac{K}{s(s+3)(s+9)}$ use frequency response methods to determine the value of gain K to yield a step response with a 15% overshoot. 10

Q4 a. Compare PI and Lag compensator to achieve the desired response, concerning to the pole zero locations and the transfer functions. Also develop the circuits for their realizations. 10

b. A unity feedback system with forward path transfer function $G(s)=\frac{K}{(s+1)(s+5)(s+8)}$ has 15% overshoot. Evaluate the current dominant poles using R.L and then design a PD controller to reduce the peak time by a factor of 2. 10

Q5 a. Design an integral controller to yield a 10% overshoot, 0.5 sec. settling time and zero steady state error for a step input for the following plant. 10

$$\dot{x} = \begin{bmatrix} -2 & 1 \\ 0 & -5 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u; \qquad y = \begin{bmatrix} 1 & 1 \end{bmatrix} x$$

b. Consider the plant $G(s) = \frac{(s+2)}{(s+5)(s+6)(s+9)}$ which is represented in observer canonical form. Design an observer with a transient response described by $\zeta=0.6$ and $w_n=120$. 10

Q6 a. Given a sampler and z.o.h. in cascade with $G(s)=\frac{K}{(s+5)}$ find the range of K to make the system stable. Sampling time T=0.1 second. 10

b. For the digital system with forward transfer function $G(z)=\frac{0.13(z+1)}{(z-1)(z-0.74)}$ find the static error constants and the steady state error if the inputs are u(t), t u(t) and $\frac{t^2}{2}u(t)$ for T=0.1 10
