10/12/2024 ELECTRICAL SEM-VI C SCHEME CSD QP CODE: 10066940

Duration: 3 Hours **Marks:80**

Note:

- **Question No.1 is compulsory.**
- Solve **any Three** questions from the **remaining** five questions.
- Assume suitable data wherever required but justify the same.
- Use of Graph paper and semilog paper is compulsory wherever applicable.

Q1 Answer any four(all questions carry equal marks) **20**

a. Write short note on ideal integral controller with respect to its characteristics and zero-pole locations.

b. Compare lag and lead compensators along with electrical equivalent circuit and pole-zero plot in S-plane

c. How Routh-Hurwitz criteria can be applied for the stability analysis for a system represented in discrete form?

d. Write the state space representation for the following system with overall transfer function as $\frac{20}{(s+7)(s+15)(s+10)}$ in cascade form.

e. Develop a flowchart for the digital compensator defined by $G_c(z)=\frac{(z+0.5)}{z^2-2.4z-1.7}$

f. List the advantages and disadvantages of controller design using state variable approach.

Q2 a. Given the plant $x' = Ax+Bu$ and $y=Cx$ with **10**

$$A = \begin{bmatrix}-1 & 1\\ 0 & 2\end{bmatrix} B = \begin{bmatrix}1\\1\end{bmatrix} C = \begin{bmatrix}0 & 1\end{bmatrix}$$

Design an integral controller to yield a 15% overshoot, 4 second settling time, and zero steady-state error for a step input.

b. Given a sampler and z.o.h. in cascade with $G(s)=\frac{20}{s(s+2)}$ in the forward path of the unity feedback system. Evaluate the static error constants and the steady-state error for the system with T=0.1 second, if the inputs are (i) u(t) (ii) t u(t) **10**

Q3 a) The open loop transfer function of a uncompensated system is $G(s)=5/s(s+2)$. Design a suitable lag compensator for the system so that static error constant Kv=20/sec, phase margin is at least 55^0 and the gain margin is at least 12 dB. Use Bode plot. **15**

b) Explain the steps in lag-lead compensator design using frequency domain analysis. **05**

Q4 a. Given the following open loop plant $G(s) = \frac{10\,(s+5)}{(s+1)(s+2)(s+4)}$ Design a controller to yield a10% overshoot and a settling time of 0.5 sec **10**

assuming that the plant is represented in the phase variable form.

b. Check the controllability and observability of the following system. **10**

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 2 \\ 1 & -2 & -4 \end{bmatrix} x + \begin{bmatrix} 1 \\ 3 \\ 1 \end{bmatrix} u; \qquad y = \begin{bmatrix} 1 & 0 & 3 \end{bmatrix} x$$

Q5 a. Consider a unity feedback system with open loop transfer function G(S)=K/s(s+1)(s+2). Design a suitable lag-lead compensator to acquire Kv=10, phase margin=50^0 and gain margin >=10 dB. Use frequency response analysis. **10**

b. Design a lag compensator using root locus technique with open loop transfer function G(S)=k/s(s+2)(s+8) to meet damping ratio =0.174. Steady state error to be improved by the factor of 10. **10**

Q6 a. Consider the following open loop plant G(s) $=\frac{25}{s(s+3)(s+4)}$ which is represented in observer canonical form. Design an observer with a transient response described by ζ=0.45 and w_n=30. Assume, the plant is represented in observer canonical form. Do the design with a suitable observer third pole. **10**

b. Given a sampler and z.o.h. in cascade with G(s)=$\frac{3K}{(s+3)}$ in the forward path of the unity feedback system. Find the range of K to make the system stable with T=0.2 second using the digital system formulation. **10**
