

1. Question no. 1 is compulsory
2. Attempt any three questions out of remaining five questions
3. Assume suitable data whenever necessary
4. Figures to the right indicate full marks

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|--------|--|-------|
| Q. 1 | Attempt All | |
| a | Compare lag and lead compensators along with electrical equivalent circuit and pole-zero plot in S-plane. | 05 |
| b | Define controllability and observability of a system. | 05 |
| c | Develop a flowchart for the digital compensator defined by | 05 |
| | $G_c(z) = \frac{X(z)}{E(z)} = \frac{z-0.8}{z^2-0.4z+0.8}$ | |
| d | Convert given transfer function into cascade form of state space | 05 |
| | $\frac{Y(s)}{U(s)} = \frac{(s+3)}{(s+2)(s+4)(s+6)}$ | |
| Q.2 a) | Design a lead compensator by root locus technique for the unity feedback system which has the forward system given by $G(S)=K/s(s+4)(s+6)$ which will reduce the settling time by a factor of 2 while maintaining 30% overshoot. | 15 |
| b) | Explain how to improve the steady state error by cascade compensation | 05 |
| Q 3 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 $K_v=20$, phase margin is at least 55° 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 |
| Q 4 a) | Design a state variable feedback controller to yield 5% overshoot and peak time of 0.3 sec for a plant $G(s)=100(S+10)/s(s+3)(s+12)$ which is represented phase variable form. | 15 |
| b) | Given $T(z) = N(Z)/D(Z)$ where $D(Z) = z^4 + z^3 - 2z + 0.5$. Use Routh-Hurwitz criterion to find the number of z plane poles of $T(z)$ inside, outside and on the unit circle. Is the system stable. | 05 |
| Q 5 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 $K_v=10$, phase margin= 50° 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 |

