LEAD AND LAG COMPENSATORS

Ideal integral and derivative controllers are used to change the response of a plant according to the required design specifications such as the settling time, speed of the response, percent overshoot, and steady-state error elimination. However, they are both active systems and require power. In addition, a derivative controller has a wide bandwidth; therefore, although it can differentiate high frequencies in the system, it can also create problems when noise is present. Alternately, a lead compensator or a lag compensator may be used. In each case, the circuits for lead and lag compensators are passive, basically consisting of resistors, capacitors, and inductors. A lead compensator has limited bandwidth and therefore may be even better for high-frequency noise reduction. Lead and lag compensation is usually performed along with frequency-domain analysis of systems (such as the Bode diagram).A lag compensator consists of a zero placed near a pole close to the origin. The addition of the pole near the origin (and not exactly at the origin, which makes it a pure integrator) acts similar to an integrator, but over time the system loses its accuracy as the steady-state error increases. Therefore, lag compensators are assumed to be leaky. The addition of the zero near the pole keeps the root locus about the same. A lead compensator consists of a zero near the origin that acts similar to a derivative controller, plus a pole near it. A lead compensator causes little change in the overall shape of the root locus, but provides for passive derivative compensation with limited bandwidth.