6 Design of Single-Loop Feedback Control Systems

In previous chapters we have become familiar with the dynamic characteristics of processes, sensor/transmitters, control valves, and controllers. We have also learned how to write linearized transfer functions for each of these components and to recognize the parameters that are significant to the design of automatic control systems: the steady-state gain, the time constants, and the dead time (transportation lag or time delay). In this chapter we will see how these concepts are put together to design and tune single-loop feedback control systems. We will first analyze a simple feedback control loop and learn how to draw a block diagram for it and determine its characteristic equation.

Then we will examine the significance of the characteristic equation in terms of how it can be used to determine the stability of the loop. We will use two methods to determine the stability of the loop: the direct substitution method and Routh's test.

The methods that we will study in this chapter are most applicable to the design of feedback control loops for industrial processes. Two other design techniques, root-locus and frequency response analysis, which have been traditionally applied to inherently linear systems, will be presented in Chapters 8 and 9, respectively.