

# Modelling and Analysis for Process Control

## CHAPTER

# 4

### 4.1 ■ INTRODUCTION

In the previous chapter, solutions to fundamental dynamic models were developed using analytical and numerical methods. The analytical integrating factor method was limited to sets of first-order linear differential equations that could be solved sequentially. In this chapter, an additional analytical method is introduced that expands the types of models that can be analyzed. The methods introduced in this chapter are tailored to the analysis of process control systems and provide the following capabilities:

1. The analytical solution of simultaneous linear differential equations with constant coefficients can be obtained using the Laplace transform method.
2. A control system can involve several processes and control calculations, which must be considered simultaneously. The overall behavior of a complex system can be modelled, considering only input and output variables, by the use of transfer functions and block diagrams.
3. The behavior of systems to sine inputs is important in understanding how the input frequency influences dynamic process performance. This behavior is most easily determined using frequency response methods.
4. A very important aspect of a system's behavior is whether it achieves a steady-state value after a step input. If it does, the system is deemed to be *stable*; if it does not, it is deemed *unstable*. Important control system analysis is based on this behavior, and the methods in this chapter are applied to determine the stability of feedback control systems in Chapter 10.