EEENG226
Signals and Systems

Chapter 2
Time-Domain Representations of Linear Time-Invariant Systems

Introduction

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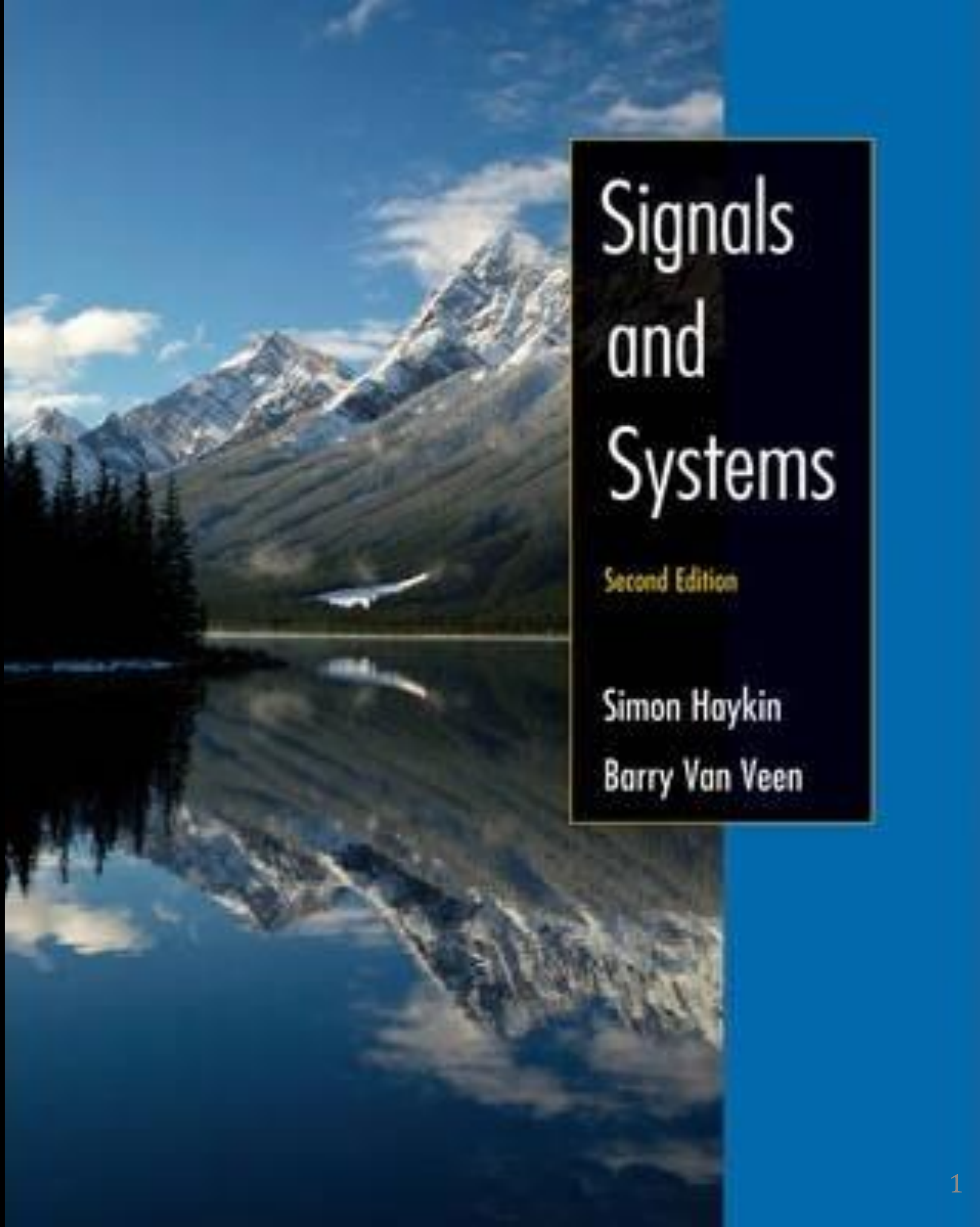

Chapter 2

Time-Domain Representations of Linear Time-Invariant Systems

Objectives of this chapter

2.1 Introduction
2.2 The Convolution Sum
2.3 Convolution Sum Evaluation Procedure
2.4 The Convolution Integral
2.5 Convolution Integral Evaluation Procedure
2.6 Interconnections of LTT Systems
2.7 Relations between LTI System Properties and the Impulse Response
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2.9 Differential and Difference Equation Representations of LTI Systems
2.10 Solving Differential and Difference Equations
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2. Time-Domain Representations of Linear Time-Invariant Systems

2.1 Introduction

- Methods for describing the relationship between the input and output signals (as functions of time) of linear time-invariant (LTI) systems in time domain
- Analyzing and predicting the behavior of LTI systems
  - Both continuous-time and discrete-time
- characterizing LTI systems i.t.o. its impulse response,
  - output of system due to unit impulse input applied at t=0 or n = 0
- Impulse response completely characterizes behavior of any LTI system

2. Time-Domain Representations of Linear Time-Invariant Systems

- Impulse response of a discrete-time system is obtained by setting the input equal to the impulse $\delta[n]$
- In continuous-time case, the impulse signal is approximated by a pulse of large amplitude and brief duration
- By linearity and time invariance, the output signal must be a weighted superposition of time-shifted impulse responses
- This weighted superposition is termed the
  - convolution sum for discrete-time systems and
  - convolution integral for continuous-time systems

2. Time-Domain Representations of Linear Time-Invariant Systems

- The second method we shall examine for characterizing the input-output behavior of LTI systems is the linear constant-coefficient differential equation (for continuous-time) or difference equation (for discrete-time systems)
- The third method of system representation we discuss is the system as an interconnection of three elementary operations:
  - scalar multiplication, addition and either a time shift for discrete-time systems or integration for continuous-time systems
- The final time-domain system representation discussed in this chapter is the state variable description
  - o a series of coupled first-order differential or difference equations that represent the behavior of the system's "state" and
  - o an equation that relates that state to output of the system
  - o The state is a set of variables associated with energy storage or memory devices in the system