WELCOME

TO

ECE 2030: Introduction to Computer Engineering*

Richard M. Dansereau
rdanse@pobox.com

*** ELEMENTS OF NOTES AFTER W. KINSNER, UNIVERSITY OF MANITOBA**

PRELIMINARIES

GOAL

LEARN BASICS BEHIND COMPUTER SYSTEMS

- Hardware architecture and organization
- Digital logic design
  - Switching and logic gate design
- Computer architecture building blocks
  - Adders/subtractors/counters
  - Shift/rotate registers
  - Multiplexers/demultiplexers and encoders/decoders
  - Controllers and sequencers
- Software mapping to hardware
  - Instruction types and assembly languages
  - OS issues, branching, jumping, interrupts, subroutines

PRELIMINARIES

OBJECTIVES

APPRECIATION OF:

- Computer system architectures and organization

KNOWLEDGE OF:

- Taxonomy of computing structures
- Switching and Boolean algebra
- Combinational logic and sequential logic
- Building blocks to computer architectures
- State machines, finite states machines
- Instruction types and addressing modes
- Single and multi-cycle data path units, microcode
- Software execution in hardware for higher level operating systems

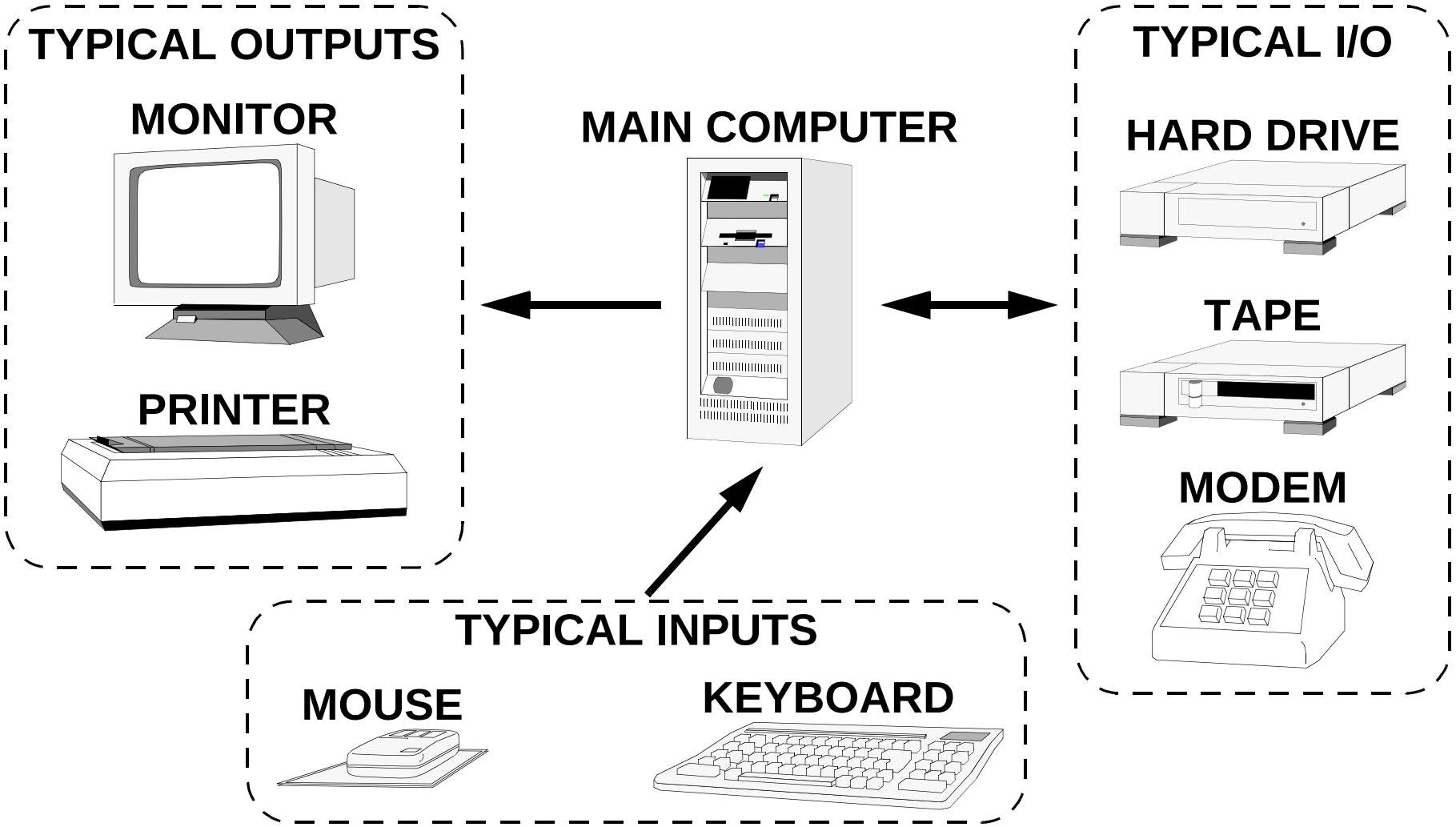
INTRO. TO COMP. ENG.
CHAPTER I-4

INTRODUCTION

SYSTEM

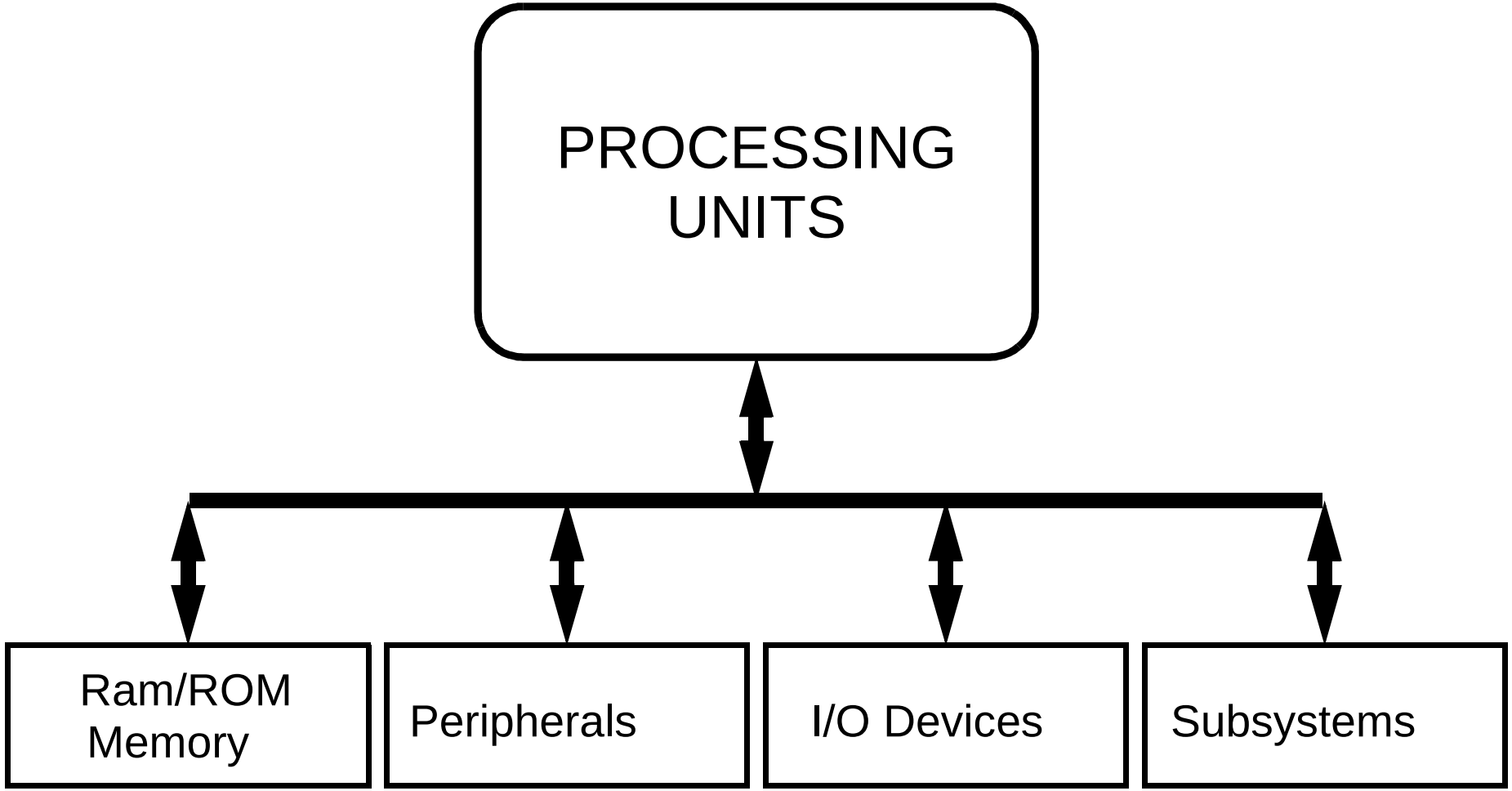
TYPICAL DESKTOP SYSTEM

- WELCOME
- PRELIMINARIES
  - -GOAL
  - -OBJECTIVES



SYSTEM

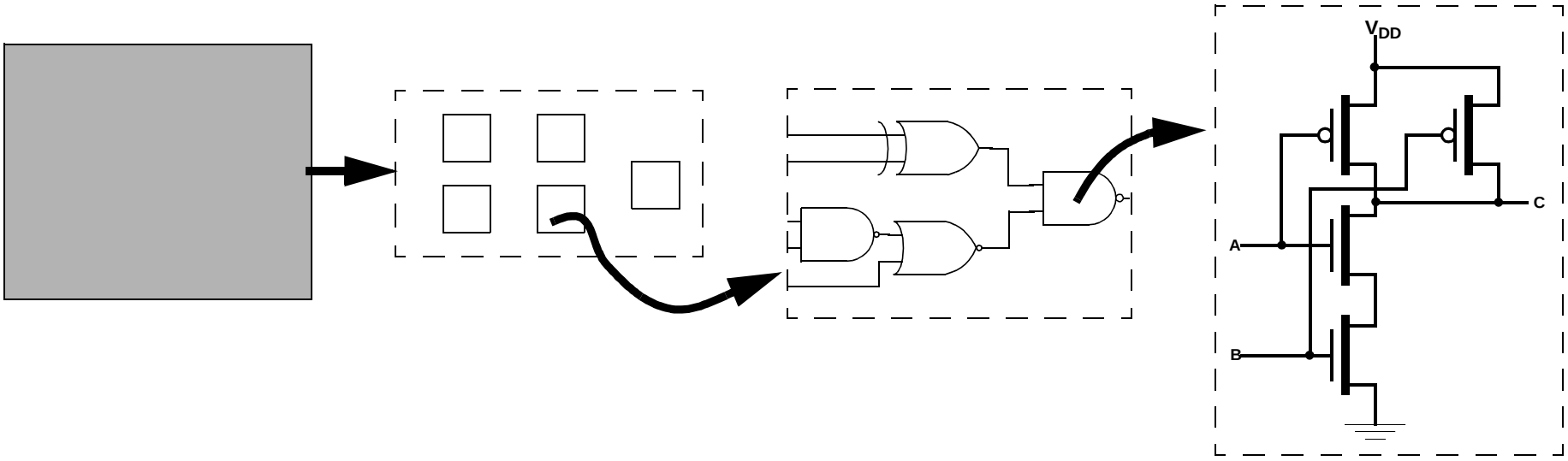
GENERIC SYSTEM



SYSTEM

HIERARCHY IN A SYSTEM

SYSTEM **MODULES** **GATES AND FLIP-FLOPS** **TRANSISTORS**



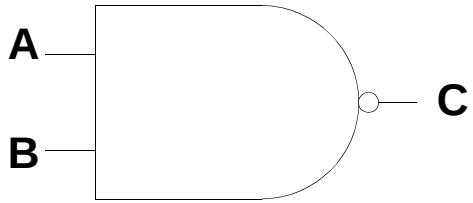
SYSTEM

NAND GATE EXAMPLE

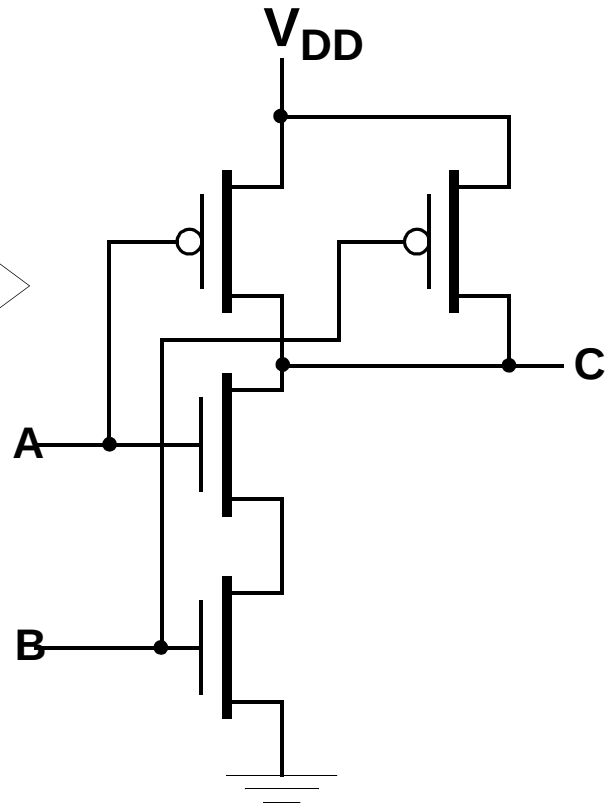
TRUTH TABLE

A	B	C
0	0	1
0	1	1
1	0	1
1	1	0

LOGIC GATE REPRESENTATION



TRANSISTOR (SWITCH) IMPLEMENTATION



SYSTEM

SYSTEM DESCRIPTION

SYSTEM LEVEL:
-Processors, memories, peripherals
-Words, files, records, programs
-HDL, natural language

REGISTER-TRANSFER LEVEL:
-Registers, ALUs, buses, CCUs
-Bytes, words, double words
-Block diagrams, state diagrams

LOGIC LEVEL:
-Gates, flip-flops
-1, 0, X (unknown); Strong, weak, Z
-Logic diagrams, boolean equations

CIRCUIT LEVEL:
-R, C, L, Diodes, Transistors
-Voltage, current, temperature
-Schematic diagrams, circuit equations

SILICON LEVEL:
Elements: -nPN & PNP transistors, CMOS
Values: -Voltage, current, temp., fields
Description: -Device models, interconnects

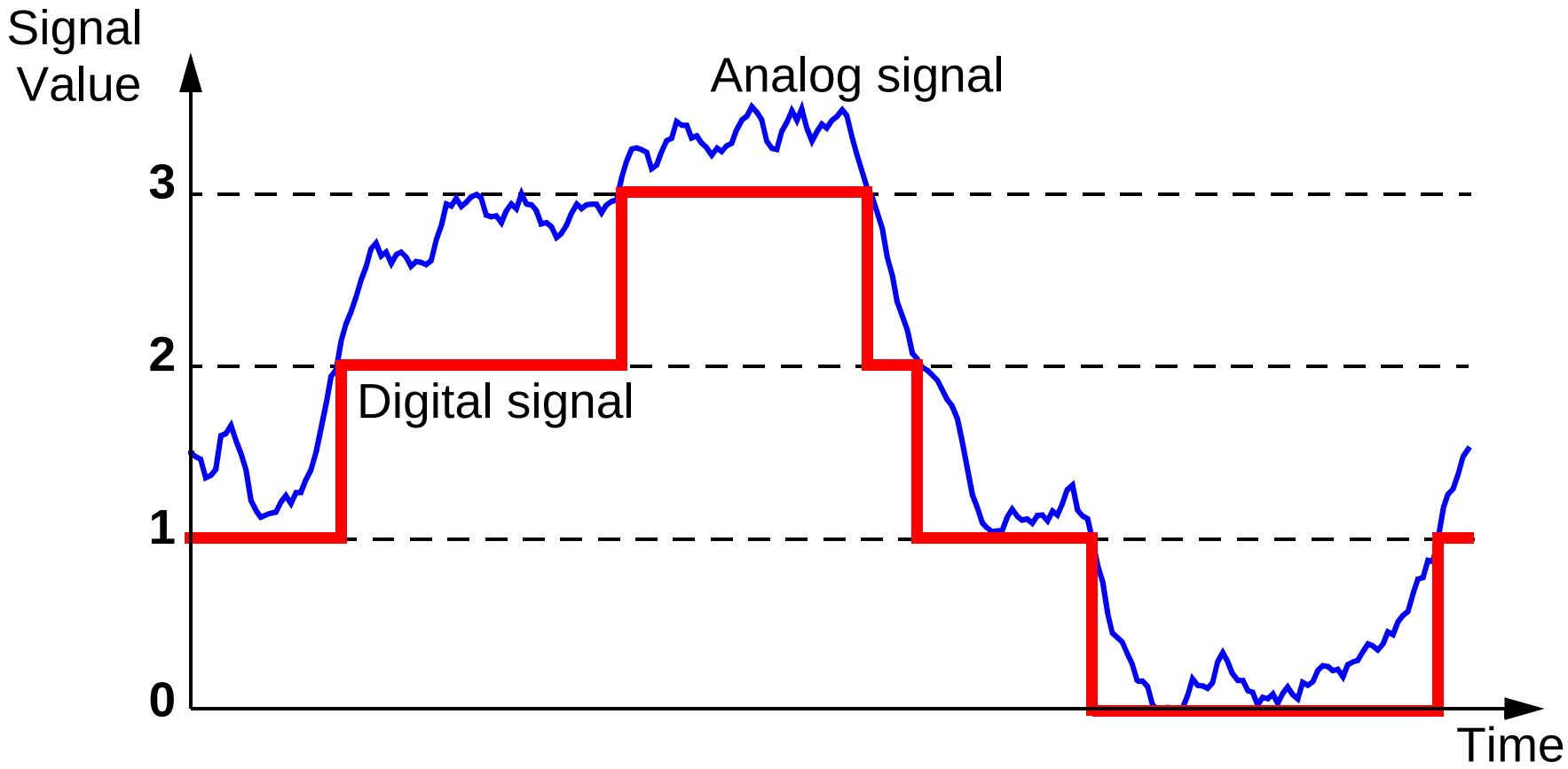
SYSTEM

LEVELS OF INTEGRATION

- **Small scale integration (SSI)**
  - ~10 transistors
  - Individual gates, flip-flops
- **Medium scale integration (MSI)**
  - 10-100 transistors
  - Adders, encoders/decodors, multiplexers, shift registers, counters
- **Large scale integration (LSI)**
  - 100-10,000 transistors
  - small memories, ROMs, PLAs, small memories
- **Very-large scale integration (VLSI)**
  - > 10,000 transistors
  - microprocessors, DSP chips, large memories

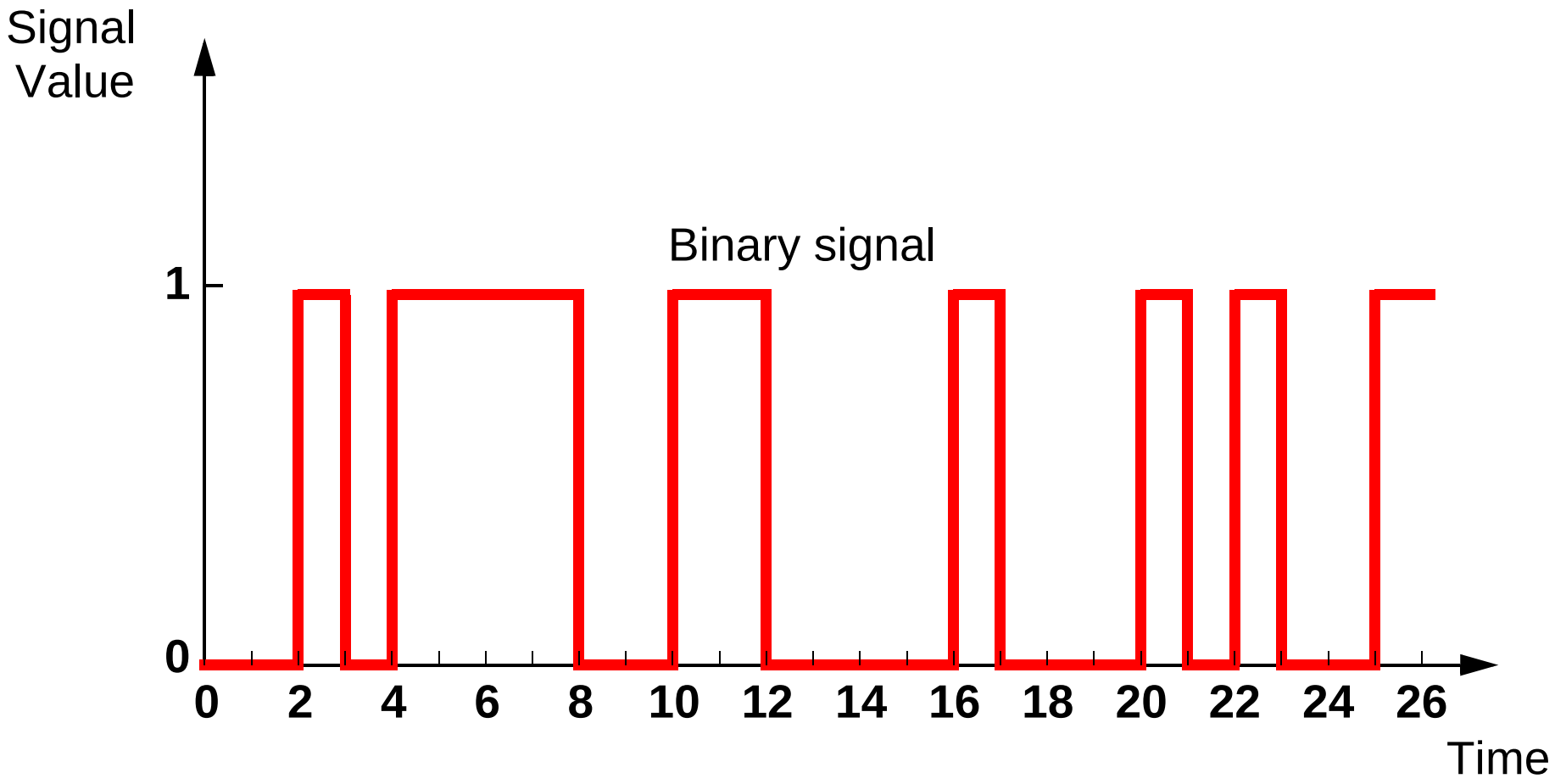
ANALOG VS. DIGITAL

A-TO-D CONVERSION



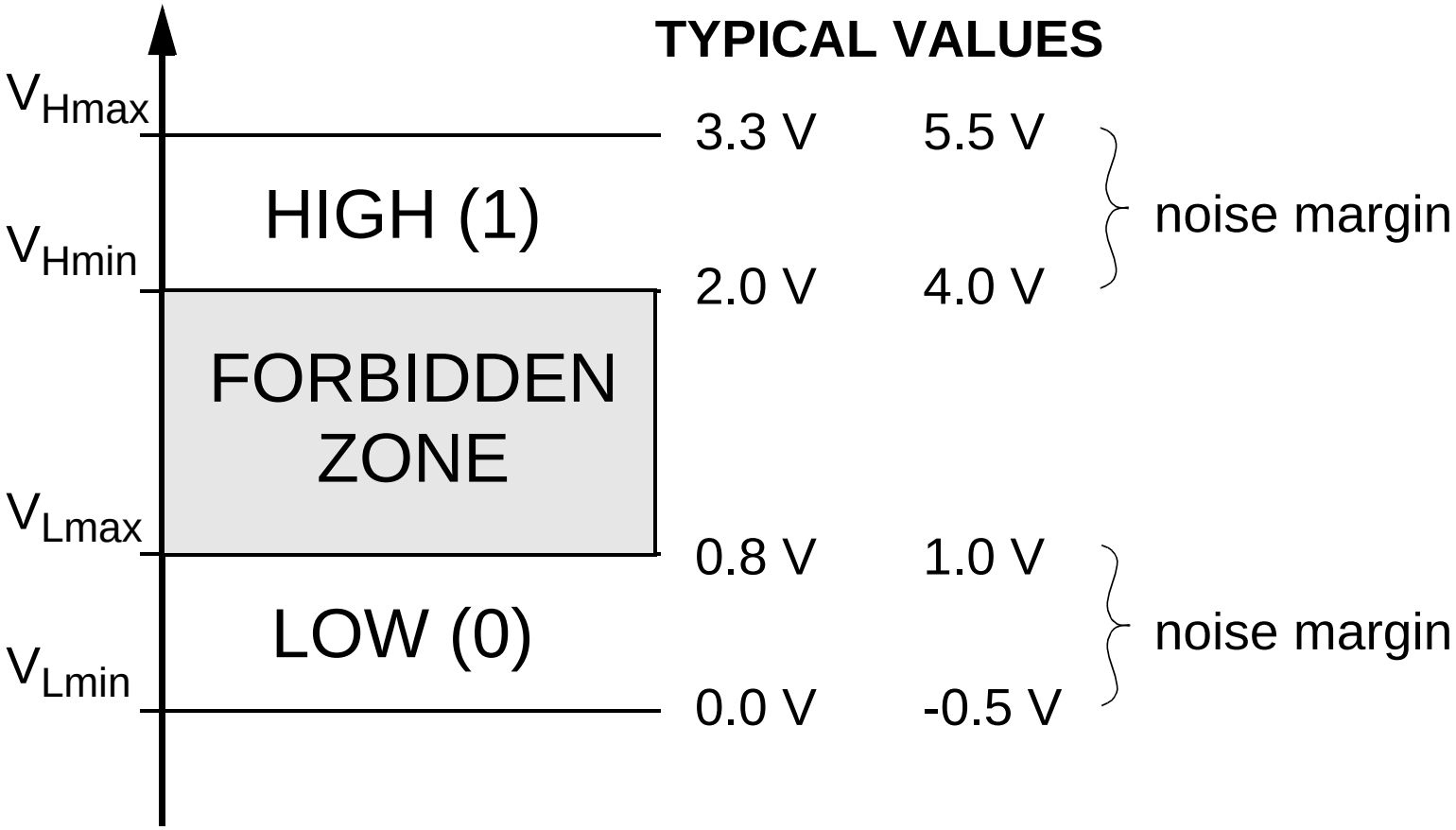
ANALOG VS. DIGITAL

BINARY SIGNAL



BINARY

BINARY LOGIC LEVELS



BINARY

BINARY NUMBERS

- Binary numbers are base 2 as opposed to base 10 typically used.
- Instead of decimal places such as 1s, 10s, 100s, 1000s, etc., binary uses powers of two to have 1s, 2s, 4s, 8s, 16s, 32s, 64s, etc. places.

Examples:

$$\mathbf{101}_2 = (\mathbf{1}\times\mathbf{2^2}) + (\mathbf{0}\times\mathbf{2^1}) + (\mathbf{1}\times\mathbf{2^0}) = \mathbf{4}_{10} + \mathbf{1}_{10} = \mathbf{5}_{10}$$

$$\mathbf{10111}_2 = (\mathbf{1}\times\mathbf{2^4}) + (\mathbf{0}\times\mathbf{2^3}) + (\mathbf{1}\times\mathbf{2^2}) + (\mathbf{1}\times\mathbf{2^1}) + (\mathbf{1}\times\mathbf{2^0}) = \mathbf{23}_{10}$$

$$\mathbf{00101111}_2 = (\mathbf{1}\times\mathbf{2^5}) + (\mathbf{1}\times\mathbf{2^3}) + (\mathbf{1}\times\mathbf{2^2}) + (\mathbf{1}\times\mathbf{2^1}) + (\mathbf{1}\times\mathbf{2^0}) = \mathbf{47}_{10}$$

- We will discuss binary numbers and binary arithmetic in a little more depth later.