

structures at the machine level, and the data representation of signed and unsigned integers, real numbers, and character data.

Assembly language has a one-to-one relationship with machine language, in which a single assembly language instruction corresponds to one machine language instruction. Assembly language is not portable because it is tied to a specific processor family.

Programming languages are tools that you can use to create individual applications or parts of applications. Some applications, such as device drivers and hardware interface routines, are

more suited to assembly language. Other applications, such as multiplatform commercial and scientific applications, are more easily written in high-level languages.

The virtual machine concept is an effective way of showing how each layer in a computer architecture represents an abstraction of a

machine. Layers can be constructed of hardware or software, and programs written at any layer can be translated or interpreted by the next lowest

layer. The virtual machine concept can be related to real-world computer layers, including digital logic, instruction set architecture, assembly language, and high-level languages.

Binary and hexadecimal numbers are essential notational tools for programmers working at

the machine level. For this reason, you must understand how to manipulate and translate between number systems and how character representations are created by computers.

The following boolean operators were presented in this chapter: NOT, AND, and OR.

A boolean expression combines a boolean operator with one or more operands. A truth table is an

effective way to show all possible inputs and outputs of a boolean function.