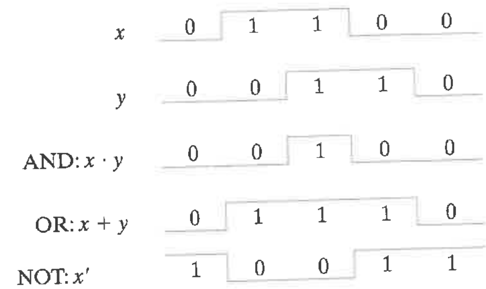
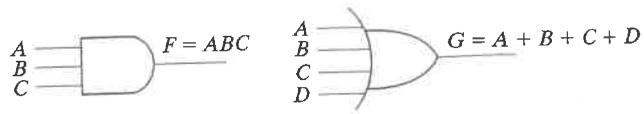


FIGURE 1.5
Input–output signals for gates



(a) Three-input AND gate (b) Four-input OR gate

FIGURE 1.6
Gates with multiple inputs

instantaneously. The low level represents logic 0 and the high level logic 1. The AND gate responds with a logic 1 output signal when both input signals are logic 1. The OR gate responds with a logic 1 output signal if any input signal is logic 1. The NOT gate is commonly referred to as an *inverter*. The reason for this name is apparent from the signal response in the timing diagram, which shows that the output signal inverts the logic sense of the input signal.

AND and OR gates may have more than two inputs. An AND gate with three inputs and an OR gate with four inputs are shown in Fig. 1.6. The three-input AND gate responds with logic 1 output if all three inputs are logic 1. The output produces logic 0 if any input is logic 0. The four-input OR gate responds with logic 1 if any input is logic 1; its output becomes logic 0 only when all inputs are logic 0.

PROBLEMS

(Answers to problems marked with * appear at the end of the text.)

1.1 (a) List the octal and hexadecimal numbers from 14_{10} to 32_{10}. Using A and B for the last two digits, list the numbers from 8_{10} to 28_{10} in base 12.

1.2* What is the exact number of bytes in a system that contains (a) 32K bytes, (b) 64M bytes, and (c) 6.4G bytes?

1.3 Convert the following numbers with the indicated bases to decimal:

(a)* $(4310)_5$ (b)* $(198)_{12}$
(c) $(445)_8$ (d) $(345)_6$

1.4 What is the largest binary number that can be expressed with 16 bits? What are the equivalent decimal and hexadecimal numbers?

1.5* Determine the base of the numbers in each case for the following operations to be correct:
(a) 14/2 = 5 (b) 56/4 = 15 (c) 32 + 12 = 28.

1.6* The solutions to the quadratic equation $x^2 - 11x + 22 = 0$ are $x = 3$ and $x = 6$. What is the base of the numbers?

1.7* Convert the hexadecimal number 64CD to binary, and then convert it from binary to octal.

1.8 Convert the decimal number 431 to binary in two ways: (a) convert directly to binary; (b) convert first to hexadecimal and then from hexadecimal to binary. Which method is faster?

1.9 Express the following numbers in decimal:
(a)* $(10110.0101)_2$ (b)* $(16.5)_{16}$
(c)* $(26.24)_8$ (d) $(DABA.B)_{16}$
(e) $(1011.1001)_2$

1.10 Convert the following binary numbers to hexadecimal and to decimal: (a) 1.10010 (b) 110.010. Explain why the decimal answer in (b) is four times that in (a).

1.11 Perform the following division in binary: 111011 ÷ 101.

1.12* Add and multiply the following numbers without converting them to decimal:
(a) Binary numbers 1011 and 101.
(b) Hexadecimal numbers 2E and 34.

1.13 Do the following conversion problems:
(a) Convert decimal 27.315 to binary.
(b) Calculate the binary equivalent of 2/3 out to eight places. Then convert from binary to decimal. How close is the result to 2/3?
(c) Convert the binary result in (b) into hexadecimal. Then convert the result to decimal. Is the answer the same?

1.14 Obtain the 1's and 2's complements of the following binary numbers:
(a) 10010000 (b) 00000000
(c) 11011010 (d) 10101010
(e) 10100101 (f) 11111111.

1.15 Find the 9's and the 10's complement of the following decimal numbers:
(a) 25,478,036 (b) 63, 325, 600
(c) 25,000,000 (d) 00,000,000.

1.16 (a) Find the 16's complement of C3AF.
(b) Convert C3AF to binary.
(c) Find the 2's complement of the result in (b).
(d) Convert the answer in (c) to hexadecimal and compare with the answer in (a).

1.17 Perform subtraction on the given unsigned numbers using the 10's complement of the subtrahend. Where the result should be negative, find its 10's complement and affix a minus sign. Verify your answers.
(a) 6,473 − 5,297 (b) 125 − 1,800
(c) 1,076 − 3,217 (d) 1,631 − 745

1.18 Perform subtraction on the given unsigned binary numbers using the 2's complement of the subtrahend. Where the result should be negative, find its 2's complement and affix a minus sign.
(a) 10011 − 10010 (b) 100010 − 100110
(c) 1001 − 110101 (d) 101000 − 10101

1.19* The following decimal numbers are shown in signed-magnitude form: +9,286 and +801. Convert them to signed-10's-complement form and perform the following operations (note that the sum is +10,627 and requires five digits and a sign).
(a) (+9,286) + (+801) (b) (+9,286) + (−801)
(c) (−9,286) + (+801) (d) (−9,286) + (−801)

1.20 Convert decimal +49 and +29 to binary, using the signed-2's-complement representation and enough digits to accommodate the numbers. Then perform the binary equivalent of (+29) + (−49), (−29) + (+49), and (−29) + (−49). Convert the answers back to decimal and verify that they are correct.

1.21 If the numbers $(+9{,}742)_{10}$ and $(+641)_{10}$ are in signed-magnitude format, their sum is $(+10{,}383)_{10}$ and requires five digits and a sign. Convert the numbers to signed-10's-complement form and find the following sums:
(a) (+9,742) + (+641) (b) (+9,742) + (−641)
(c) (−9,742) + (+641) (d) (−9,742) + (−641)

1.22 Convert decimal 6,514 and 3,274 to both BCD and ASCII codes. For ASCII, an even parity bit is to be appended at the left.

1.23 Represent the unsigned decimal numbers 791 and 658 in BCD, and then show the steps necessary to form their sum.

1.24 Formulate a weighted binary code for the decimal digits, using the following weights:
(a)* 6, 3, 1, 1 (b) 6, 4, 2, 1

1.25 Represent the decimal number 6,428 in (a) BCD, (b) excess-3 code, (c) 2421 code, and (d) 6311 code.

1.26 Find the 9's complement of the decimal number 6,248 and express it in 2421 code. Show that the result is the 1's complement of the answer to (c) in Problem 1.25. This demonstrates that the 2421 code is self-complementing.

1.27 Assign a binary code in some orderly manner to the 52 playing cards. Use the minimum number of bits.

1.28 Write the expression "G. Boole" in ASCII, using an eight-bit code. Include the period and the space. Treat the leftmost bit of each character as a parity bit. Each eight-bit code should have odd parity. (George Boole was a 19th-century mathematician. Boolean algebra, introduced in the next chapter, bears his name.)

1.29* Decode the following ASCII code:
1010011 1110100 1100101 1110110 1100101 0100000 1001010 1101111 1100010 1110011

1.30 The following is a string of ASCII characters whose bit patterns have been converted into hexadecimal for compactness: 73 F4 E5 76 E5 4A EF 62 73. Of the eight bits in each pair of digits, the leftmost is a parity bit. The remaining bits are the ASCII code.
(a) Convert the string to bit form and decode the ASCII.
(b) Determine the parity used: odd or even?