

1. True or False? A voltage level in the range 0 to 2 volts is interpreted as a binary 1.
2. True or False? A gate is a device that accepts a single input signal and produces one or more output signals.
3. True or False? A circuit is a combination of gates designed to accomplish a more complex logical function.
4. True or False? A logic diagram and a truth table are equally powerful techniques for describing the behavior of a circuit.
5. True or False? A NOT gate allows only one of its two input values to pass.
6. True or False? The inversion bubble of an AND gate causes its input to be reversed.
7. True or False? An AND gate and an OR gate produce opposite output.
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9. True or False? The OR and XOR gates produce different outputs in only one case.
10. True or False? An OR gate is sometimes referred to as an inclusive OR.
11. True or False? A NAND gate and a AND gate produce opposite output.
12. True or False? A NAND gate and a NOR gate produce opposite output.
13. True or False? A gate with three inputs has 8 possible input combinations.
14. True or False? A gate is constructed of one or more transistors.
15. True or False? A transistor is made of material that acts as a good insulator, such as rubber.
16. True or False? If an electrical signal is grounded, the electricity literally flows harmlessly to the ground.
17. True or False? A NOT gate can be made from a single transistor.
18. True or False? In a sequential circuit, the output is determined solely by the input values.
19. True or False? Two different circuits cannot produce the same output given the same input.
20. True or False? Boolean algebra allows us to apply provable mathematical principles to the design of circuits.
21. True or False? DeMorgan's law states that inverting the output of an AND gate is equivalent to inverting the individual input signals and then passing them through an OR gate.
22. True or False? A circuit can be used to add two binary digits together and produce a carry bit.
23. True or False? A multiplexer produces multiple outputs for each input.

24. True or False? A circuit cannot be used as memory because input signals are lost as soon as they pass through a gate.

25. True or False? A single integrated circuit can have more than 100,000 gates on it.

26. True or False? The central processing unit (CPU) of a computer is often a single integrated circuit.

27. Which of the following is a device that performs a basic operation on electrical signals?

- A. logic symbol
- B. truth table
- C. gate
- D. circuit
- E. S-R latch

28. Which of the following lists all possible input combinations for a gate, and the corresponding output?

- A. truth table
- B. Boolean expression
- C. logic diagram
- D. circuit
- E. S-R latch

29. The circle in the logic symbol of a NOT gate is known as what?

- A. combinational circuit
- B. sequential circuit
- C. completion sphere
- D. inversion bubble
- E. NAND gate

30. What is a regular OR gate also known as?

- A. exclusive OR
- B. inclusive OR
- C. repetitive OR
- D. completion OR
- E. inversion OR

31. Which gate does the following logic symbol represent?



- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

32. Which gate does the following logic symbol represent?



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- E. NOR
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35. Which gate does the following logic symbol represent?



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- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

36. Which gate does the following logic symbol represent?



- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

37. Which gate does the following truth table represent?

A	X
0	1
1	0

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

38. Which gate does the following truth table represent?

A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

39. Which gate does the following truth table represent?

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

40. Which gate does the following truth table represent?

A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

41. Which gate does the following truth table represent?

A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

42. Which gate does the following truth table represent?

A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

43. Which gate does the following Boolean expression represent?

$$X = A'$$

- A. AND
- B. NAND
- C. XOR
- D. OR

- E. NOR
- F. NOT

44. Which gate does the following Boolean expression represent?

$$X = A \bullet B$$

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

45. Which gate does the following Boolean expression represent?

$$X = A + B$$

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

46. Which gate does the following Boolean expression represent?

$$X = A \oplus B$$

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

47. Which gate does the following Boolean expression represent?

$$X = (A \bullet B)'$$

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

48. Which gate does the following Boolean expression represent?

$$X = (A + B)'$$

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

49. Which gate inverts its input?

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

50. Which gate produces a 1 only if all its inputs are 1 and a 0 otherwise?

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

51. Which gate produces a 0 only if all its inputs are 0 and a 1 otherwise?

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

52. Which gate produces a 0 only if all its inputs are the same and a 1 otherwise?

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

53. Which gate produces a 0 if all its inputs are 1 and a 1 otherwise?

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

54. Which gate produces a 1 if all its inputs are 0 and a 0 otherwise?

- A. AND
- B. NAND

- C. XOR
- D. OR
- E. NOR
- F. NOT

55. How many possible input combinations exist for an OR gate with three inputs?

- A. 2
- B. 4
- C. 8
- D. 16
- E. 32

56. Generally, how many possible input combinations exist for a gate with n inputs?

- A. $2n$
- B. $n + 1$
- C. $4n$
- D. $4n - 2$
- E. 2^n

57. A transistor is made up of what kind of material?

- A. semiconductor
- B. conductor
- C. insulation
- D. rubber
- E. copper

58. A transistor acts like which of the following?

- A. a light
- B. a button
- C. a switch
- D. a frame
- E. a memory location

59. If the input to a transistor (its base signal) is low, what is its output?

- A. binary 0
- B. binary 1
- C. 0 volts
- D. 15 volts
- E. ground

60. Which of the following determines the output of a combinational circuit?

- A. its input values only
- B. its input values and the current state of the circuit
- C. its input values and the source signal
- D. its input values and the carry value
- E. its input values and the select signal

61. Which of the following determines the output of a sequential circuit?

- A. its input values only

- B. its input values and the current state of the circuit
- C. its input values and the source signal
- D. its input values and the carry value
- E. its input values and the select signal

62. Under what circumstances are two circuits considered equivalent?

- A. their input values are the same
- B. the output of one is the inverse of the output of the other
- C. their output values are the same for all possible input combinations
- D. their output values are always 1
- E. the input of one matches the output of the other

63. The following equation is an example of which Boolean algebra property?

$$AB = BA$$

- A. commutative
- B. associative
- C. distributive
- D. identity
- E. complement
- F. DeMorgan's law

64. The following equation is an example of which Boolean algebra property?

$$(AB)C = A(BC)$$

- A. commutative
- B. associative
- C. distributive
- D. identity
- E. complement
- F. DeMorgan's law

65. The following equation is an example of which Boolean algebra property?

$$A(B+C) = (AB) + (AC)$$

- A. commutative
- B. associative
- C. distributive
- D. identity
- E. complement
- F. DeMorgan's law

66. The following equation is an example of which Boolean algebra property?

$$A1 = A$$

- A. commutative
- B. associative

- C. distributive
- D. identity
- E. complement
- F. DeMorgan's law

67. The following equation is an example of which Boolean algebra property?

$$A(A') = 0$$

- A. commutative
- B. associative
- C. distributive
- D. identity
- E. complement
- F. DeMorgan's law

68. The following equation is an example of which Boolean algebra property?

$$(AB)' = A' + B'$$

- A. commutative
- B. associative
- C. distributive
- D. identity
- E. complement
- F. DeMorgan's law

69. Which gate produces the sum portion of two binary digits in a half adder?

- A. NOT
- B. AND
- C. OR
- D. XOR
- E. NAND
- F. NOR

70. Which gate produces the carry portion of two binary digits in a half adder?

- A. NOT
- B. AND
- C. OR
- D. XOR
- E. NAND
- F. NOR

71. A multiplexer (or mux) does which of the following?

- A. adds two binary digits, taking the carry value into account
- B. acts as a memory circuit for a single binary digit
- C. contains multiple S-R latch circuits
- D. selects a single output value from a set of input values
- E. merges multiple input values into a single output value

72. An S-R latch does which of the following?

- A. adds two binary digits, taking the carry value into account
- B. acts as a memory circuit for a single binary digit
- C. contains multiple S-R latch circuits
- D. selects a single output value from a set of input values
- E. merges multiple input values into a single output value

73. A VLSI chip contains how many gates?

- A. 0
- B. 2
- C. 1 to 10
- D. 10 to 100
- E. 100 to 100,000
- F. more than 100,000

74. The central processing unit of a computer is which of the following?

- A. gate
- B. stand-alone circuit
- C. integrated circuit
- D. S-R latch
- E. multiplexer
- F. full adder

75. A _____ is a device that performs a basic operation on electrical signals.

76. _____ expressions can be used to describe the behavior of gates and circuits.

77. _____ diagrams can be used to describe the behavior of gates and circuits.

78. _____ tables can be used to describe the behavior of gates and circuits.

79. A _____ defines the function of a gate by listing all possible input combinations for the gate and the corresponding output.

80. A _____ gate produces the inverse of its single input.

81. The circle that's part of the logic diagram symbol for a NOT gate is called a(n) _____ bubble.

82. A gate that accepts two input values has _____ possible input combinations.

83. An _____ gate produces an output of 1 only if both input values are 1.

84. An _____ gate produces an output of 0 only if both input values are 0.

85. The Boolean expression $A \oplus B$ represents a _____ gate.

86. The XOR gate is also referred to as a(n) _____ OR gate.

87. The OR and XOR gates produce different values only when both inputs are _____.

88. The gate that produces the opposite results of an AND gate is called a _____ gate.
89. A _____ acts as either conducts or blocks the flow of electricity, based on an input value
90. A _____ acts like a switch, even though it has no moving parts.
91. In a _____ circuit, the input values explicitly determine the output.
92. In a _____ circuit, the output is determined by the input as well as the existing state of the circuit.
93. Two circuits are considered to be _____ if they produce the same output for each input value combination.
94. The equation $A(B+C) = (AB)+(AC)$ represents the _____ property (or law) of AND gates.
95. The equation $(AB)' = A' + B'$ represents the _____ property (or law) of AND gates.
96. A circuit that produces the sum of two binary digits, taking the carry bit into account, is called a(n) _____.
97. A _____ is a circuit that selects a single output value from a set of inputs based on select signals
98. An S-R latch is a circuit that can be used as _____.
99. A _____ circuit has multiple gates embedded into it.
100. A _____ chip contains more than 100,000 gates.
101. What three notations can be used to describe the behavior of gates and circuits?
102. Compare the output of an AND gate and a NAND gate.
103. How is an exclusive OR gate different than a regular OR gate?
104. Draw the truth table for a NOT gate.
105. Draw the truth table for an AND gate.
106. Draw the truth table for an OR gate.

107. Draw the truth table for an XOR gate.

108. Draw the truth table for a NAND gate.

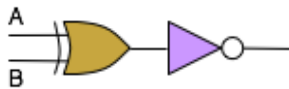
109. Draw the truth table for a NOR gate.

110. What is the relationship between the number of inputs a gate has and the size of the truth table that describes it.

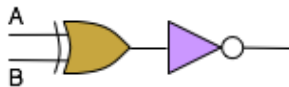
111. What is a transistor?

112. How many transistors does it take to create a NOT gate? A NAND gate? An AND gate?

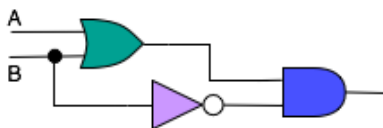
113. Give the Boolean expression for the following circuit diagram.



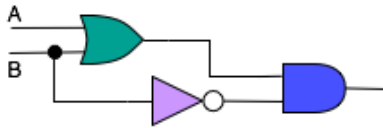
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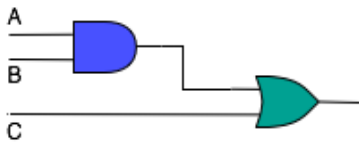
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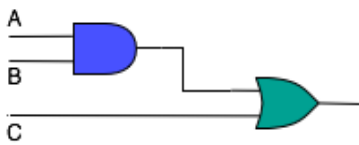
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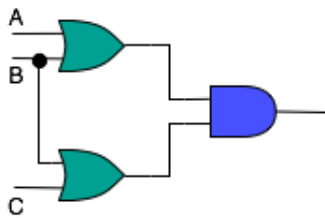
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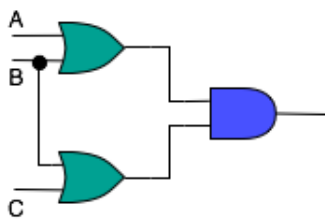
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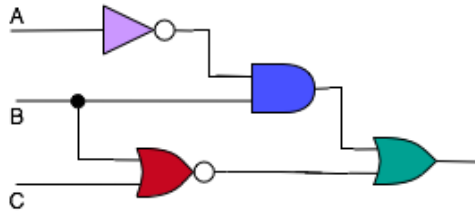
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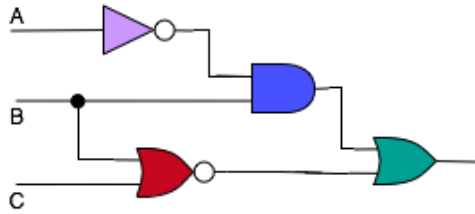
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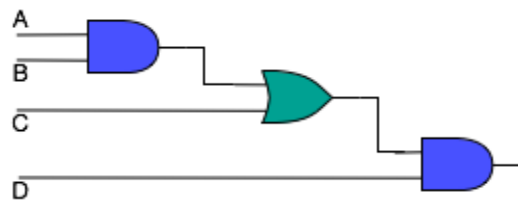
121. Give the Boolean expression for the following circuit diagram.



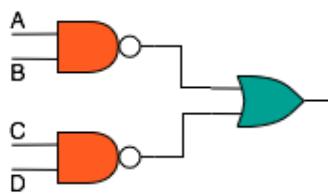
122. Draw the truth table for the following circuit diagram.



123. Give the Boolean expression for the following circuit diagram.



124. Give the Boolean expression for the following circuit diagram.



125. Draw a circuit diagram for the following truth table.

A	B	AB	A+B	$AB + (A+B)$
0	0	0	1	1
0	1	0	1	1
1	0	0	1	1
1	1	1	0	1

126. Draw a circuit diagram for the following truth table.

A	B	A'	AB	$A' \oplus (AB)$
0	0	1	0	1
0	1	1	0	1
1	0	0	0	0
1	1	0	1	1

127. Draw a circuit diagram for the following truth table.

A	B	C	A'	$B \oplus C$	$A'(B \oplus C)$
0	0	0	1	0	0
0	0	1	1	1	1
0	1	0	1	1	1
0	1	1	1	0	0
1	0	0	0	0	0
1	0	1	0	1	0
1	1	0	0	1	0
1	1	1	0	0	0

128. Draw a circuit diagram for the following truth table.

A	B	C	AB	$(BC)'$	C'	$(AB+C')'$	$(BC)' + (AB+C')'$
0	0	0	0	1	1	0	1
0	0	1	0	1	0	1	1
0	1	0	0	1	1	0	1
0	1	1	0	0	0	1	1
1	0	0	0	1	1	0	1
1	0	1	0	1	0	1	1
1	1	0	1	1	1	0	1
1	1	1	1	0	0	0	0

129. Draw the logic diagram for a half adder.

130. Draw the logic diagram for a full adder.

131. What is a half adder?

132. What is a multiplexer?

133. What is an integrated circuit?

Essay-type questions

134. Describe the three notations used to describe the behavior of gates and circuits.

135. Compare and contrast an OR gate and an XOR gate.

136. Explain how a transistor is used to create a gate.

137. Explain the concept of circuit equivalence.

138. Describe in your own words the processing of a half adder.

139. How can a VLSI chip have over 100,000 gates on it, but still have a reasonably small number of pins?

140. Describe in your own words the issues related to conflict of interest.

141. Describe in your own words the issues related to intellectual property.

Answers

1. True or False? A voltage level in the range 0 to 2 volts is interpreted as a binary 1.

Answer: False

2. True or False? A gate is a device that accepts a single input signal and produces one or more output signals.

Answer: False

3. True or False? A circuit is a combination of gates designed to accomplish a more complex logical function.

Answer: True

4. True or False? A logic diagram and a truth table are equally powerful techniques for describing the behavior of a circuit.

Answer: True

5. True or False? A NOT gate allows only one of its two input values to pass.

Answer: False

6. True or False? The inversion bubble of an AND gate causes its input to be reversed.

Answer: False

7. True or False? An AND gate and an OR gate produce opposite output.

Answer: False

8. True or False? An OR gate produces a 0 output only if its two input values are 0.

Answer: True

9. True or False? The OR and XOR gates produce different outputs in only one case.

Answer: True

10. True or False? An OR gate is sometimes referred to as an inclusive OR.

Answer: True

11. True or False? A NAND gate and a AND gate produce opposite output.

Answer: True

12. True or False? A NAND gate and a NOR gate produce opposite output.

Answer: False

13. True or False? A gate with three inputs has 8 possible input combinations.

Answer: True

14. True or False? A gate is constructed of one or more transistors.

Answer: True

15. True or False? A transistor is made of material that acts as a good insulator, such as rubber.

Answer: False

16. True or False? If an electrical signal is grounded, the electricity literally flows harmlessly to the ground.

Answer: True

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Answer: False

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Answer: True

21. True or False? DeMorgan's law states that inverting the output of an AND gate is equivalent to inverting the individual input signals and then passing them through an OR gate.

Answer: True

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Answer: True

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Answer: False

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Answer: False

25. True or False? A single integrated circuit can have more than 100,000 gates on it.

Answer: True

26. True or False? The central processing unit (CPU) of a computer is often a single integrated circuit.

Answer: True

Multiple Choice

27. Which of the following is a device that performs a basic operation on electrical signals?

- A. logic symbol
- B. truth table
- C. gate
- D. circuit
- E. S-R latch

Answer: C

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- B. Boolean expression
- C. logic diagram
- D. circuit
- E. S-R latch

Answer: A

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- B. sequential circuit
- C. completion sphere
- D. inversion bubble
- E. NAND gate

Answer: D

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- A. exclusive OR
- B. inclusive OR
- C. repetitive OR
- D. completion OR
- E. inversion OR

Answer: B

31. Which gate does the following logic symbol represent?



- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: F

32. Which gate does the following logic symbol represent?



- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: A

33. Which gate does the following logic symbol represent?



- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: D

34. Which gate does the following logic symbol represent?



- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: C

35. Which gate does the following logic symbol represent?



- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: B

36. Which gate does the following logic symbol represent?



- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: E

37. Which gate does the following truth table represent?

A	X
0	1
1	0

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: F

38. Which gate does the following truth table represent?

A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: A

39. Which gate does the following truth table represent?

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: D

40. Which gate does the following truth table represent?

A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: C

41. Which gate does the following truth table represent?

A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: B

42. Which gate does the following truth table represent?

A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: E

43. Which gate does the following Boolean expression represent?

$$X = A'$$

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: F

44. Which gate does the following Boolean expression represent?

$$X = A \bullet B$$

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: A

45. Which gate does the following Boolean expression represent?

$$X = A + B$$

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: D

46. Which gate does the following Boolean expression represent?

$$X = A \oplus B$$

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: C

47. Which gate does the following Boolean expression represent?

$$X = (A \bullet B)'$$

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: B

48. Which gate does the following Boolean expression represent?

$$X = (A + B)'$$

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: E

49. Which gate inverts its input?

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: F

50. Which gate produces a 1 only if all its inputs are 1 and a 0 otherwise?

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: A

51. Which gate produces a 0 only if all its inputs are 0 and a 1 otherwise?

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: D

52. Which gate produces a 0 only if all its inputs are the same and a 1 otherwise?

- A. AND
- B. NAND
- C. XOR

- D. OR
- E. NOR
- F. NOT

Answer: C

53. Which gate produces a 0 if all its inputs are 1 and a 1 otherwise?

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: B

54. Which gate produces a 1 if all its inputs are 0 and a 0 otherwise?

- A. AND
- B. NAND
- C. XOR
- D. OR
- E. NOR
- F. NOT

Answer: E

55. How many possible input combinations exist for an OR gate with three inputs?

- A. 2
- B. 4
- C. 8
- D. 16
- E. 32

Answer: C

56. Generally, how many possible input combinations exist for a gate with n inputs?

- A. $2n$
- B. $n + 1$
- C. $4n$
- D. $4n - 2$
- E. 2^n

Answer: E

57. A transistor is made up of what kind of material?

- A. semiconductor

- B. conductor
- C. insulation
- D. rubber
- E. copper

Answer: A

58. A transistor acts like which of the following?

- A. a light
- B. a button
- C. a switch
- D. a frame
- E. a memory location

Answer: C

59. If the input to a transistor (its base signal) is low, what is its output?

- A. binary 0
- B. binary 1
- C. 0 volts
- D. 15 volts
- E. ground

Answer: B

60. Which of the following determines the output of a combinational circuit?

- A. its input values only
- B. its input values and the current state of the circuit
- C. its input values and the source signal
- D. its input values and the carry value
- E. its input values and the select signal

Answer: A

61. Which of the following determines the output of a sequential circuit?

- A. its input values only
- B. its input values and the current state of the circuit
- C. its input values and the source signal
- D. its input values and the carry value
- E. its input values and the select signal

Answer: B

62. Under what circumstances are two circuits considered equivalent?

- A. their input values are the same
- B. the output of one is the inverse of the output of the other

- C. their output values are the same for all possible input combinations
- D. their output values are always 1
- E. the input of one matches the output of the other

Answer: B

63. The following equation is an example of which Boolean algebra property?

$$AB = BA$$

- A. commutative
- B. associative
- C. distributive
- D. identity
- E. complement
- F. DeMorgan's law

Answer: A

64. The following equation is an example of which Boolean algebra property?

$$(AB)C = A(BC)$$

- A. commutative
- B. associative
- C. distributive
- D. identity
- E. complement
- F. DeMorgan's law

Answer: B

65. The following equation is an example of which Boolean algebra property?

$$A(B+C) = (AB) + (AC)$$

- A. commutative
- B. associative
- C. distributive
- D. identity
- E. complement
- F. DeMorgan's law

Answer: C

66. The following equation is an example of which Boolean algebra property?

$$A1 = A$$

- A. commutative
- B. associative
- C. distributive
- D. identity
- E. complement
- F. DeMorgan's law

Answer: D

67. The following equation is an example of which Boolean algebra property?

$$A(A') = 0$$

- A. commutative
- B. associative
- C. distributive
- D. identity
- E. complement
- F. DeMorgan's law

Answer: E

68. The following equation is an example of which Boolean algebra property?

$$(AB)' = A' + B'$$

- A. commutative
- B. associative
- C. distributive
- D. identity
- E. complement
- F. DeMorgan's law

Answer: F

69. Which gate produces the sum portion of two binary digits in a half adder?

- A. NOT
- B. AND
- C. OR
- D. XOR
- E. NAND
- F. NOR

Answer: D

70. Which gate produces the carry portion of two binary digits in a half adder?

- A. NOT

- B. AND
- C. OR
- D. XOR
- E. NAND
- F. NOR

Answer: B

71. A multiplexer (or mux) does which of the following?
- A. adds two binary digits, taking the carry value into account
 - B. acts as a memory circuit for a single binary digit
 - C. contains multiple S-R latch circuits
 - D. selects a single output value from a set of input values
 - E. merges multiple input values into a single output value

Answer: D

72. An S-R latch does which of the following?
- A. adds two binary digits, taking the carry value into account
 - B. acts as a memory circuit for a single binary digit
 - C. contains multiple S-R latch circuits
 - D. selects a single output value from a set of input values
 - E. merges multiple input values into a single output value

Answer: B

73. A VLSI chip contains how many gates?
- A. 0
 - B. 2
 - C. 1 to 10
 - D. 10 to 100
 - E. 100 to 100,000
 - F. more than 100,000

Answer: F

74. The central processing unit of a computer is which of the following?
- A. gate
 - B. stand-alone circuit
 - C. integrated circuit
 - D. S-R latch
 - E. multiplexer
 - F. full adder

Answer: C

Fill-in-the-Blank

75. A _____ is a device that performs a basic operation on electrical signals.

Answer: Gate

76. _____ expressions can be used to describe the behavior of gates and circuits.

Answer: Boolean

77. _____ diagrams can be used to describe the behavior of gates and circuits.

Answer: Logic

78. _____ tables can be used to describe the behavior of gates and circuits.

Answer: Truth

79. A _____ defines the function of a gate by listing all possible input combinations for the gate and the corresponding output.

Answer: truth table

80. A _____ gate produces the inverse of its single input.

Answer: NOT

81. The circle that's part of the logic diagram symbol for a NOT gate is called a(n) _____ bubble.

Answer: Inversion

82. A gate that accepts two input values has _____ possible input combinations.

Answer: Four

83. An _____ gate produces an output of 1 only if both input values are 1.

Answer: AND

84. An _____ gate produces an output of 0 only if both input values are 0.

Answer: OR

85. The Boolean expression $A \oplus B$ represents a _____ gate.

Answer: XOR

86. The XOR gate is also referred to as a(n) _____ OR gate.

Answer: Exclusive

87. The OR and XOR gates produce different values only when both inputs are _____.

Answer: 1

88. The gate that produces the opposite results of an AND gate is called a _____ gate.

Answer: NAND

89. A _____ acts as either conducts or blocks the flow of electricity, based on an input value

Answer: Transistor

90. A _____ acts like a switch, even though it has no moving parts.

Answer: Transistor

91. In a _____ circuit, the input values explicitly determine the output.

Answer: Combinational

92. In a _____ circuit, the output is determined by the input as well as the existing state of the circuit.

Answer: Sequential

93. Two circuits are considered to be _____ if they produce the same output for each input value combination.

Answer: Equivalent

94. The equation $A(B+C) = (AB)+(AC)$ represents the _____ property (or law) of AND gates.

Answer: Distributive

95. The equation $(AB)' = A' + B'$ represents the _____ property (or law) of AND gates.

Answer: DeMorgan's

96. A circuit that produces the sum of two binary digits, taking the carry bit into account, is called a(n) _____.

Answer: Adder

97. A _____ is a circuit that selects a single output value from a set of inputs based on select signals

Answer: Multiplexer

98. An S-R latch is a circuit that can be used as _____.

Answer: Memory

99. A _____ circuit has multiple gates embedded into it.

Answer: Integrated

100. A _____ chip contains more than 100,000 gates.

Answer: VLSI, or Very-Large-Scale Integration

Short Answer

101. What three notations can be used to describe the behavior of gates and circuits?

Answer: Boolean expressions, logic diagrams, and truth tables

102. Compare the output of an AND gate and a NAND gate.

Answer: The output of an AND gate is 1 only if both inputs are 1. A NAND gate produces the exact opposite output.

103. How is an exclusive OR gate different than a regular OR gate?

Answer: The output of the two gates is identical except when both input values are 1, in which case an OR gate produces a 1 but an exclusive OR produces a 0.

104. Draw the truth table for a NOT gate.

Answer:

A	A'
0	1
1	0

105. Draw the truth table for an AND gate.

Answer:

A	B	AB
0	0	0
0	1	0
1	0	0
1	1	1

106. Draw the truth table for an OR gate.

Answer:

A	B	A+B
0	0	0
0	1	1
1	0	1
1	1	1

107. Draw the truth table for an XOR gate.

A	B	$A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

Answer:

108. Draw the truth table for a NAND gate.

A	B	$(AB)'$
0	0	1
0	1	1
1	0	1
1	1	0

Answer:

109. Draw the truth table for a NOR gate.

A	B	$(A+B)'$
0	0	1
0	1	0
1	0	0
1	1	0

Answer:

110. What is the relationship between the number of inputs a gate has and the size of the truth table that describes it.

Answer: There are 2^n possible input combinations for a gate with n inputs, so there are 2^n rows in the truth table that describes it.

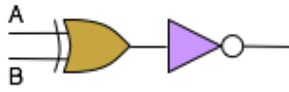
111. What is a transistor?

Answer: A transistor is a device that acts like a switch, either allowing electricity to flow or blocking it, depending on the voltage level of its input signal.

112. How many transistors does it take to create a NOT gate? A NAND gate? An AND gate?

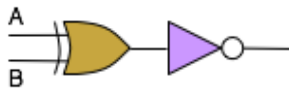
Answer: It takes one transistor to make a NOT gate, two to make a NAND gate, and three to make an AND gate.

113. Give the Boolean expression for the following circuit diagram.



Answer: $(A \oplus B)'$

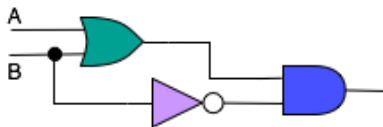
114. Draw the truth table for the following circuit diagram.



A	B	$A \oplus B$	$(A \oplus B)'$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

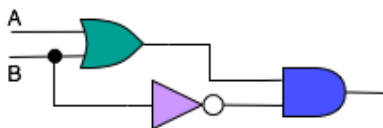
Answer:

115. Give the Boolean expression for the following circuit diagram.



Answer: $(A+B) \cdot B'$

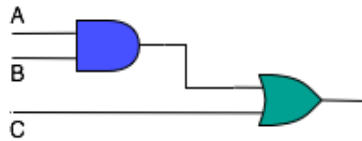
116. Draw the truth table for the following circuit diagram.



A	B	A+B	B'	$(A+B) \cdot B'$
0	0	0	1	0
0	1	1	0	0
1	0	1	1	1
1	1	1	0	0

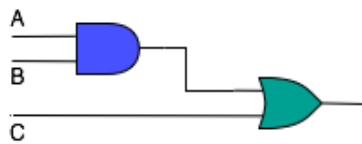
Answer:

117. Give the Boolean expression for the following circuit diagram.



Answer: $(AB) + C$

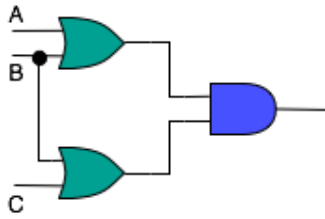
118. Draw the truth table for the following circuit diagram.



A	B	C	AB	$(AB) + C$
0	0	0	0	0
0	0	1	0	1
0	1	0	0	0
0	1	1	0	1
1	0	0	0	0
1	0	1	0	1
1	1	0	1	1
1	1	1	1	1

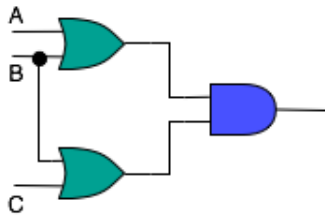
Answer:

119. Give the Boolean expression for the following circuit diagram.



Answer: $(A+B)(B+C)$

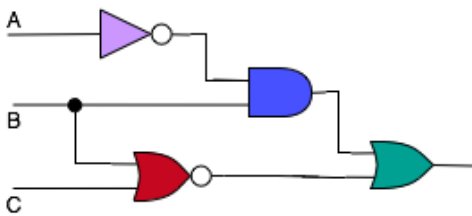
120. Draw the truth table for the following circuit diagram.



A	B	C	A+B	B+C	$(A+B)(B+C)$
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	1	1	1
0	1	1	1	1	1
1	0	0	1	0	0
1	0	1	1	1	1
1	1	0	1	1	1
1	1	1	1	1	1

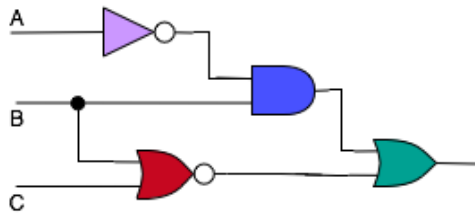
Answer:

121. Give the Boolean expression for the following circuit diagram.



Answer: $A'B + (B+C)'$

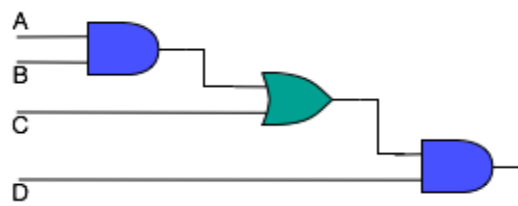
122. Draw the truth table for the following circuit diagram.



A	B	C	A'	A'B	(B+C)'	A'B + (B+C)'
0	0	0	1	0	1	1
0	0	1	1	0	0	0
0	1	0	1	1	0	1
0	1	1	1	1	0	1
1	0	0	0	0	1	1
1	0	1	0	0	0	0
1	1	0	0	0	0	0
1	1	1	0	0	0	0

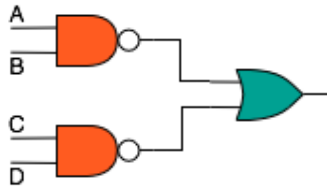
Answer:

123. Give the Boolean expression for the following circuit diagram.



Answer: $(AB + C)D$

124. Give the Boolean expression for the following circuit diagram.

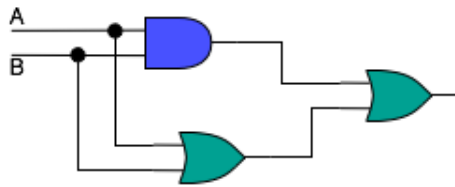


Answer: $(AB)' + (CD)'$

125. Draw a circuit diagram for the following truth table.

A	B	AB	A+B	$AB + (A+B)$
0	0	0	1	1
0	1	0	1	1
1	0	0	1	1
1	1	1	0	1

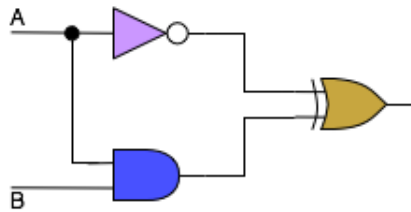
Answer:



126. Draw a circuit diagram for the following truth table.

A	B	A'	AB	$A' \oplus (AB)$
0	0	1	0	1
0	1	1	0	1
1	0	0	0	0
1	1	0	1	1

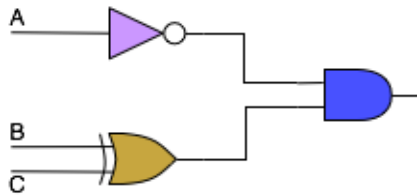
Answer:



127. Draw a circuit diagram for the following truth table.

A	B	C	A'	$B \oplus C$	$A'(B \oplus C)$
0	0	0	1	0	0
0	0	1	1	1	1
0	1	0	1	1	1
0	1	1	1	0	0
1	0	0	0	0	0
1	0	1	0	1	0
1	1	0	0	1	0
1	1	1	0	0	0

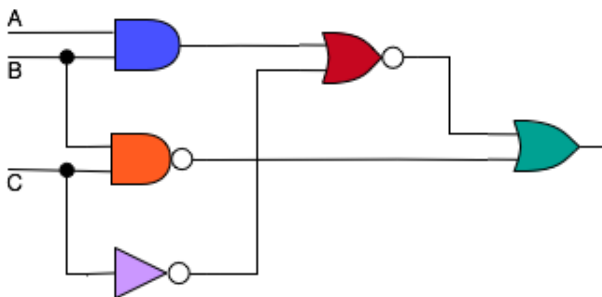
Answer:



128. Draw a circuit diagram for the following truth table.

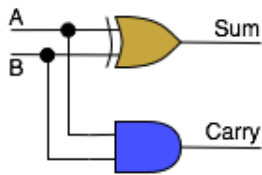
A	B	C	AB	$(BC)'$	C'	$(AB+C')'$	$(BC)' + (AB+C')'$
0	0	0	0	1	1	0	1
0	0	1	0	1	0	1	1
0	1	0	0	1	1	0	1
0	1	1	0	0	0	1	1
1	0	0	0	1	1	0	1
1	0	1	0	1	0	1	1
1	1	0	1	1	1	0	1
1	1	1	1	0	0	0	0

Answer:



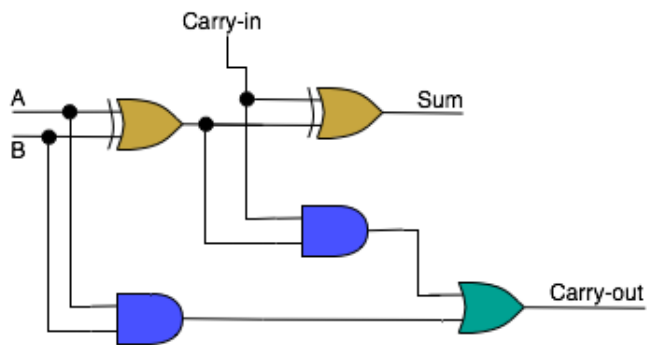
129. Draw the logic diagram for a half adder.

Answer:



130. Draw the logic diagram for a full adder.

Answer:



131. What is a half adder?

Answer: A half adder is a circuit that computes the sum of two bits and produces the appropriate carry bit.

132. What is a multiplexer?

Answer: A multiplexer is a circuit that uses input control signals to determine which of several data input lines is to be routed to the output.

133. What is an integrated circuit?

Answer: An integrated circuit, or chip, is a piece of silicon on which multiple gates have been embedded.

Essay

134. Describe the three notations used to describe the behavior of gates and circuits.

Answer: Boolean expressions represent the behavior of a gate or circuit using equations with logical operators. Based in Boolean algebra, these equations can be manipulated in formal, mathematical ways. Logic diagrams are a graphical representation of a circuit. Using special symbols for each type of gate, a circuit can be represented by connecting the output of one gate to the input of another. Truth tables list all possible input combinations to a circuit and the corresponding output. Columns in a truth table might be used to show the intermediate results of circuit processing.

135. Compare and contrast an OR gate and an XOR gate.

Answer: An OR gate produces an output of 1 if either or both input values are 1. Therefore, an OR gate produces an output of 0 only in one situation, when both input values are 0. An XOR gate, which stands for exclusive OR, produces an output of 1 if either input is 1, but not if both inputs are 1 at the same time. So an XOR gate produces identical output to an OR gate except in the case when both input values are 1. An XOR gate produces an output 0 in two situations, when both input values are 0 and when both input values are 1.

136. Explain how a transistor is used to create a gate.

Answer: A transistor has an input line, an output line, a grounded emitter, and an electrical source. If the input signal is high, the source is grounded and the output is low. If the input signal is low, the source is not grounded and the output is high. Thus, a single transistor acts as a NOT gate, inverting its input signal. Using two transistors, its possible to construct NAND and NOR gates. Using a third transistor to reverse the output of the NAND and NOR gates, its possible to construct AND and OR gates.

137. Explain the concept of circuit equivalence.

Answer: Two circuits are considered to be equivalent if they produce the same output for all possible input combinations. That is, two different circuits, made up of different gates and connections, can be equivalent in the function they perform. When designing a circuit, its often cost effective to minimize the number of components that make up a circuit, as long as it produces the desired result.

138. Describe the processing of a half adder.

Answer: A half adder is a circuit that produces two outputs, the sum bit and the carry bit. The two input binary digits are passed through an XOR gate to produce the sum, and the same input bits are passed through an AND gate to produce the carry. The extra digit is needed only when both inputs are 1. When that occurs, the XOR gate produces a sum bit of zero and the AND gate produces a carry bit of 1. In all other cases, the carry bit will be 0.

139. How can a VLSI chip have over 100,000 gates on it, but still have a reasonably small number of pins?

Answer: An SSI chip has only a few gates on it, and so it is reasonable to have pins corresponding to every input and output value for each gate. But a VLSI chip, with over 100,000 gates, cannot have pins corresponding to each gate. Instead, a VLSI chip is designed to contain a circuit made up of thousands of

gates, but using only a few input and output values. Instead of providing the functionality of several gates on one chip, it provides the functionality of one complex circuit.

140. Describe in your own words the issues related to conflict of interest.

Answer: see p.111 of text

141. Describe in your own words the issues related to intellectual property.

Answer: see p.111 of text