

Class 11

Chapter – 2

Propositional Logic and Hardware

MULTIPLE CHOICE QUESTIONS (Page 89-91)

1. Which connective represents “if and only if”?

Options: (a) \wedge (b) \vee (c) \leftrightarrow (d) \rightarrow

Explanation:

“If and only if” means both statements are equivalent. The symbol used is \leftrightarrow .

Answer:

(c) \leftrightarrow

2. The contrapositive of $(p \rightarrow q)$ is:

Options: (a) $q \rightarrow p$ (b) $\neg q \rightarrow \neg p$ (c) $\neg p \rightarrow \neg q$ (d) $p \leftrightarrow q$

Explanation:

Rule: Contrapositive of $(p \rightarrow q)$ is $(\neg q \rightarrow \neg p)$

Answer:

(b) $\neg q \rightarrow \neg p$

3. XOR is true when:

Options: (a) Both inputs are true (b) Both inputs are false (c) Inputs differ (d) Inputs are same

Explanation:

XOR gives output 1 only when inputs are different.

Truth Table: $0 \text{ XOR } 0 = 0$ $0 \text{ XOR } 1 = 1$ $1 \text{ XOR } 0 = 1$ $1 \text{ XOR } 1 = 0$

Answer:

(c) Inputs differ

4. Which connective is associative?

Options: (a) AND (b) OR (c) Both AND & OR (d) XOR only

Explanation:

Both AND and OR satisfy associative law.

Example: $(A + B) + C = A + (B + C)$

Answer:

(c) Both AND & OR

5. Which of the following is a tautology?

Options: (a) $(p \vee \neg p)$ (b) $(p \wedge \neg p)$ (c) $(p \rightarrow p)$ (d) Both (a) & (c)

Explanation:

A tautology is always true.

$(p \vee \neg p)$ is always true. $(p \rightarrow p)$ is also always true.

Answer:

(d) Both (a) & (c)

6. Which law allows replacement of $(p \rightarrow q)$ with $(\neg p \vee q)$?

Options: (a) Contrapositive law (b) Implication law (c) Distributive law (d) Identity law

Explanation:

Implication law: $p \rightarrow q = \neg p \vee q$

Answer:

(b) Implication law

7. Which method can be used to prove syllogism?

Options: (a) Truth table method (b) Algebraic method (c) Both (a) & (b) (d) None

Explanation:

Both truth table and algebraic methods can prove syllogism.

Answer:

(c) Both (a) & (b)

LOGIC GATES MCQs

8. The output of an AND gate is 1 when:

Options: (a) Any input is 1 (b) All inputs are 1 (c) Inputs differ (d) All inputs are 0

Explanation:

AND gate gives output 1 only when all inputs are 1.

Truth Table: 1 AND 1 = 1

Answer:

(b) All inputs are 1

9. The NOT gate is also called:

Options: (a) Inverter (b) Buffer (c) Comparator (d) Amplifier

Explanation:

NOT gate reverses the input. 0 becomes 1 1 becomes 0 So it is called an inverter.

Answer:

(a) Inverter

10. The OR gate output is 0 when:

Options: (a) Any input is 1 (b) All inputs are 0 (c) Inputs differ (d) Both inputs are 1

Explanation:

OR gate gives 0 only when all inputs are 0.

Answer:

(b) All inputs are 0

11. Which gate has truth table opposite to AND?

Options: (a) OR (b) NAND (c) NOR (d) XOR

Explanation:

NAND = NOT of AND. So its output is opposite of AND gate.

Answer:

(b) NAND

12. NAND gate is equivalent to:

Options: (a) NOT + AND (b) NOT + OR (c) NOT + XOR (d) NOT + NOR

Explanation:

NAND means: First AND operation then NOT operation.

Answer:

(a) NOT + AND

13. NOR gate is equivalent to:

Options: (a) NOT + AND (b) NOT + OR (c) NOT + NAND (d) NOT + XOR

Explanation:

NOR means: First OR operation then NOT operation.

Answer:

(b) NOT + OR

14. Which gate is called Universal Gate?

Options: (a) AND (b) OR (c) NAND (d) NOR

Explanation:

NAND and NOR are universal gates because they can create all other gates.

Answer:

(c) NAND

15. XOR gate output is 1 when:

Options: (a) Inputs are same (b) Inputs differ (c) Both inputs are 0 (d) Both inputs are 1

Explanation:

XOR output becomes 1 only when inputs are different.

Answer:

(b) Inputs differ

16. XNOR gate is also called:

Options: (a) Equivalence gate (b) Exclusive OR gate (c) Universal gate (d) Comparator gate

Explanation:

XNOR checks equality. If both inputs are same \rightarrow output 1. So it is called equivalence gate.

Answer:

(a) Equivalence gate

17. Which gate outputs 1 only when all inputs are 0?

Options: (a) NAND (b) NOR (c) XOR (d) XNOR

Explanation:

NOR gate gives 1 only when all inputs are 0.

Answer:

(b) NOR

18. Which gate can implement NOT gate?

Options: (a) NAND (b) NOR (c) Both (a) & (b) (d) XOR

Explanation:

Both NAND and NOR can act as NOT gate.

Answer:

(c) Both (a) & (b)

19. XOR gate is equivalent to:

$(A \vee B) \wedge \neg(A \wedge B)$

Explanation:

XOR means either A or B is true but not both.

Answer:

(a)

20. A half adder requires this gate combination:

Options: (a) AND + OR (b) XOR + AND (c) NAND + NOR (d) XOR + OR

Explanation:

Half adder: Sum = XOR gate Carry = AND gate

Answer:

(b) XOR + AND

21. Which combination implements a full adder?

Options: (a) 1 XOR, 3 AND (b) 1 XOR, 1 OR (c) 2 NAND, 1 NOR (d) 3 XOR only

Explanation:

Full adder uses XOR, AND and OR gates.

Answer:

(a) 1 XOR, 3 AND

22. Carry output of half adder is:

Options: (a) $A \oplus B$ (b) $A.B$ (c) $A + B$ (d) $(A.B)'$

Explanation:

Carry comes only when both inputs are 1. That is AND operation.

Answer:

(b) $A.B$

23. Sum output of full adder is:

Options: (a) $A \oplus B \oplus C$ (b) $A.B.C$ (c) $A + B + C$ (d) $(A.B)'$

Explanation:

Full adder sum is obtained using XOR operation.

Answer:

(a) $A \oplus B \oplus C$

24. Which gate combination can implement any Boolean function?

Options: (a) AND + OR (b) NAND only (c) NOR only (d) Both NAND & NOR

Explanation:

NAND and NOR are universal gates. They can create any Boolean function.

Answer:

(d) Both NAND & NOR

ASSERTIONS AND REASONS

1.

Assertion: NAND is a universal gate. Reason: Any Boolean function can be implemented using only NAND gates.

Explanation:

Both statements are true and reason correctly explains assertion.

Answer:

(a)

2.

Assertion: Law of double negation states $\neg(\neg p) = p$. Reason: Negating twice restores truth value.

Answer:

(a)

3.

Assertion: OR gate output is 1 if any input is 1. Reason: OR gate is used for logical addition.

Answer:

(a)

4.

Assertion: NOR gate is a universal gate. Reason: NOR can implement NOT, AND and OR.

Answer:

(a)

5.

Assertion: Half adder can add two bits. Reason: Half adder takes two inputs only.

Answer:

(a)

6.

Assertion: Full adder can add three bits. Reason: Two half adders without extra gate can work as full adder.

Explanation:

Assertion is true but reason is false because OR gate is also needed.

Answer:

(c)

7.

Assertion: XNOR gate is called equivalence gate. Reason: XNOR outputs 1 when inputs are equal.

Answer:

(a)

8.

Assertion: $(p \rightarrow q)$ is false when $p = 1$ and $q = 0$. Reason: True cannot imply false.

Answer:

(a)

9.

Assertion: NAND gate is equivalent to NOT followed by AND. Reason: NAND gate is also equivalent to AND followed by NOT.

Explanation:

Assertion is false but reason is true.

Answer:

(d)

10.

Assertion: Carry output of half adder is A.B. Reason: Carry occurs only when both inputs are 1.

Answer:

(a)

11.

Assertion: XOR outputs 1 when inputs differ. Reason: XOR output is 1 when both inputs are 1.

Explanation:

Assertion true, reason false.

Answer:

(c)

12.

Assertion: XOR output is HIGH only when odd number of inputs are HIGH. Reason: XOR performs modulo-2 addition.

Answer:

(a)

13.

Assertion: Equivalence expression is $p \leftrightarrow q$. Reason: Equivalence statement always gives contingencies.

Explanation:

Assertion true, reason false.

Answer:

(c)

14.

Assertion: Contrapositive of $p' \Rightarrow q$ is $q' \Rightarrow p$. Reason: Contrapositive is obtained by interchanging antecedent and consequent.

Explanation:

Contrapositive also requires negation.

Answer:

(c)

ASSIGNMENT SOLUTIONS (PAGE 99–102)

TYPE A : VERY SHORT ANSWER QUESTIONS

All drawing and truth table you do it your shelf

1. What is proposition?

Answer:

A proposition is a statement that is either TRUE or FALSE.

Example:

- Delhi is capital of India. (True)
- $2 + 2 = 5$ (False)

2. What do you mean by contingency, tautology and contradiction?

Answer:

- Tautology \rightarrow Always true
- Contradiction \rightarrow Always false
- Contingency \rightarrow Sometimes true and sometimes false

3. What is a logic gate? Name the three basic logic gates.

Answer:

A logic gate is an electronic circuit that performs logical operations.

Three basic logic gates:

1. AND gate
2. OR gate
3. NOT gate

4. Which gates implement logical addition, multiplication and complementation?

Answer:

- OR gate → Logical addition
- AND gate → Logical multiplication
- NOT gate → Complementation

5. Write the precedence order of logical operators.

Answer:

Order of precedence:

1. NOT
2. AND
3. OR
4. Implication
5. Biconditional

6. What is the other name of NOT gate?

Answer:

NOT gate is also called Inverter.

7. What is a truth table?

Answer:

A truth table shows all possible input combinations and outputs.

Another name: Truth function table.

8. According to which law are these expressions true?

$$X + (Y + Z) = (X + Y) + Z \quad X(YZ) = (XY)Z$$

Answer:

Associative Law

9. Which law states $X(Y + Z) = XY + XZ$?

Answer:

Distributive Law

10. What is the following property called?

$$X.(Y + Z) = X.Y + X.Z$$

Answer:

Distributive Law

11. What is the following property called?

$$X + XY = X$$

Answer:

Absorption Law

12. Rules $X + Y = X.Y$ and $X.Y = X + Y$ are known as?

Answer:

De Morgan's Laws

13. Identify incorrect statements.

Correct forms:

(d) $AA' = 0$ (g) $(A + B)' = A'B'$ (h) $(AB)' = A' + B'$ (l) $X + YZ = (X + Y)(X + Z)$

14. What is a connective?

Answer:

A connective joins two or more propositions.

Example: AND, OR, NOT

15. Name the process for the compounds.

(i) $p + q \rightarrow$ Disjunction (ii) $p.q \rightarrow$ Conjunction (iii) $p \Rightarrow q \rightarrow$ Implication (iv) $\sim p \rightarrow$ Negation (v) $p \Leftrightarrow q \rightarrow$ Biconditional

16. What are contingencies?

Answer:

Statements that are sometimes true and sometimes false.

17. Form converse, inverse and contrapositive of $p \Rightarrow q$.

Answer:

- Converse $\rightarrow q \Rightarrow p$
 - Inverse $\rightarrow \sim p \Rightarrow \sim q$
 - Contrapositive $\rightarrow \sim q \Rightarrow \sim p$
-

18. What is syllogism?

Answer:

Syllogism is a logical argument formed using two premises and one conclusion.

19. Why are NAND and NOR called universal gates?

Answer:

Because all logic gates can be made using NAND or NOR gates only.

20. Which gates are called universal gates and why?

Answer:

NAND and NOR gates. They can implement all Boolean functions.

21. Draw logic circuit using NAND or NOR.

Answer:

Students should draw the circuit using NAND gates for: $F(a,b)=a'b'+ab$
This represents XNOR function.

22. Difference between half adder and full adder.

Half Adder:

- Adds two bits
- No carry input

Full Adder:

- Adds three bits
- Has carry input

23. What is inverted AND gate called?

Answer:

NAND gate

What is inverted OR gate called?

Answer:

NOR gate

24. When does XOR gate produce HIGH output?

Answer:

When inputs are different.

When does XNOR produce HIGH output?

Answer:

When inputs are same.

25. Applications of logic networks.

Answer:

1. Adders
2. Encoders
3. Decoders
4. Multiplexers
5. Computers
6. Digital circuits

TYPE B : SHORT ANSWER QUESTIONS

1. Construct compound sentences.

Given: p = It is raining q = It is not a sunny day

- (i) p' → It is not raining (ii) $p \cdot q$ → It is raining and it is not a sunny day (iii) $p + q$ → It is raining or it is not a sunny day (iv) $p \Rightarrow q$ → If it is raining then it is not a sunny day (v) $p \Leftrightarrow q$ → It is raining if and only if it is not a sunny day

2. Symbolic forms.

- (i) I like coffee and tea → $p \cdot q$ (ii) I like coffee but not tea → $p \cdot \sim q$ (iii) Either coffee or tea → $p + q$

3. If r stands for “I will go to school” and t for “I will watch a movie”.

Expression: $\sim s + t$

Meaning:

I will not go to school or I will watch a movie.

4. Establish using truth table.

Answer:

The given expressions are logically equivalent.

5. Find results.

(i) $x=0, y=1 \Rightarrow x \wedge y = 0$

(ii) $x=1, y=1 \Rightarrow x \vee y = 1$

6. Determine converse, inverse and contrapositive.

Given: $p \Rightarrow q$

Converse $\rightarrow q \Rightarrow p$ Inverse $\rightarrow \sim p \Rightarrow \sim q$ Contrapositive $\rightarrow \sim q \Rightarrow \sim p$

7. Find tautologies and contradictions.

Answer:

Expressions always true \rightarrow tautologies. Expressions always false \rightarrow contradictions.

8. Construct truth table.

Answer:

Students should make truth table using all combinations of p and q.

9–13 Validity and conclusions.

Answer:

Use logical implication rules and Modus Ponens.

14. Determine satisfiable, contradictory or valid.

Definitions:

- Satisfiable \rightarrow true for at least one case
 - Contradictory \rightarrow always false
 - Valid \rightarrow always true
-

15. Meaning of statements.

Answer:

Translate each symbol into English using:

- \wedge = and
 - \vee = or
 - \sim = not
 - \Rightarrow = if...then
-

16. Truth value and proposition.

Answer:

Truth value means TRUE or FALSE. A proposition is a logical statement having a truth value.

17. Logical function.

Answer:

A logical function gives output based on logical operations. Alternative name → Boolean function. (do it yourself)

18. Tautology and contradiction.

Answer:

Tautology → always true. Contradiction → always false.

19. What is a truth table?

Answer:

A truth table shows all possible combinations of inputs and outputs. Significance: It helps verify logical expressions.

20–28 Truth table proofs.

Answer:

Students should draw truth tables using 0 and 1 combinations. (do it yourself)

29. Prove the following.

Answer:

Use Boolean algebra laws: (do it yourself)

- Identity law
 - Absorption law
 - Distributive law
 - De Morgan's law
-

30. Draw logic circuit diagrams.

Answer:

Use combinations of AND, OR and NOT gates. (do it yourself)

31. Design 3-input circuit.

Answer:

Use XOR gates for odd/even parity circuits. (do it yourself)

32. Design logic circuit.

Answer:

Use truth table and simplify using Boolean algebra. (do it yourself)

33. Realize Boolean function.

Answer:

Implement using AND-OR-NOT gates. (do it yourself)

34–39 Logic circuit questions.

Answer:

Students should draw circuits using NAND/NOR implementations. (do it yourself)

LONG ANSWER QUESTIONS (PAGE 102)

40(a) State De Morgan's Laws.

Laws:

1. $(A + B)' = A'.B'$
2. $(AB)' = A' + B'$

Explanation:

The complement of OR becomes AND. The complement of AND becomes OR.

40(c) Truth table for Full Adder.

A	B	C in	Sum	Carry
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

41(c) Draw logic circuit for half adder.

Answer:

Half adder uses:

- XOR gate for SUM
 - AND gate for CARRY(do it yourself)
-

42(c) Draw logic circuit for Full Adder.

Answer:

A full adder uses: (do it yourself)

- Two XOR gates
 - Two AND gates
 - One OR gate
-

43(a) State Absorption Laws.

Laws:

1. $A + AB = A$
2. $A(A + B) = A$

Explanation: (do it yourself)

Extra term gets absorbed.

(b) will be discussed in the class -
