

Special Symbols : Variables & Constant, Symbolization, Five Basic Truth Functions

1. Symbolic logic is entirely formal in nature- is it true?

Answer:- Yes

2. Not is/ is not a logical constant.

Answer:- Is

3. Application of ideogram is /is not a characteristic of symbolic logic.

Answer- Is

4. Symbolic logic uses deductive/inductive method.

Answer:- Deductive.

5. If p is true and q is also true, what is the value of $\sim p \vee q$?

Answer- true.

6. 'v' represents conjunction/ disjunction.

Answer:- Disjunction.

7. Symbolize – 'If I have money and also friends then I can organize the function'.

Answer. $(p.q) \supset r$

8. Variable / is not a logical constant.

Answer :- is not

9. $p \vee q$ stands for either he will not attend the meeting or he will - Is it true?

Answer- no

10. Phonogram stands for sound.

11. Ideogram stands for sound/concept.

Answer:- concept.

12. A variable is/ is not a symbol

Answer:- Is.

13. Illustrate variable.

Answer- p,q,r,s.

14. Symbolize 'he is neither intelligent nor industrious'.

Answer- $\sim p \vee \sim q$

15. Find the value of $\sim (\sim q \supset \sim p)$, if truth is the value of both the variables.

Answer :- $\sim (\sim q \supset \sim p)$

$= \sim (\sim T \supset \sim T)$

$= \sim (F \supset F)$

$= \sim T = F$

16. What is symbolic logic?

Answer:- Symbolic logic is the name given to that part and the method of treatment of formal logic which is comparatively of recent origin and in which specialized symbols are used extensively to express the arguments as to determine their value in a better and easier way.

17. What is symbol?

Answer:- Symbol is a sign which is consciously designed to stand for something, for example, the national flag of a nation is the symbol of that nation.

18. Define variable.

Answer:- Generally variable means changeable. In logic variable means a symbol which can stand for anyone of the given range of values. Variables are those symbols which do not have any fixed meaning. They can be given any range of values.

19. Define constant.

Answer: Logical constants are those symbols which exhibits the form of compound proposition and which bears the same meaning in the symbolic expression of proposition the following are the logical constants.

Negative (not) – ' $\sim$ ' (curl)

And- ' $\cdot$ ' (dot)

If... then – ' $\supset$ ' (horseshoe)

Either... or – ' $\vee$ ' (vel)

Equivalence (if and only) – ' $\equiv$ ' (three bar)

20. Define classical logic.

Answer:- Classical logic is the name given to those parts and that method of treatment of formal logic which have come down substantially are changed from classical and medieval time.

21. What is the relation between symbolic and classical logic?

Answer- 1. Both the two systems are concerned with forms and validity of arguments.

2. Modern logic is the development of concepts and technique which were implied in the work of Aristotle, the founder of classical logic.

22. What is called a truth value of a proposition?

Answer:- Truth or falsity is the very essence or character of a proposition. The truth or falsity of a proposition is called its truth value.

23. What are the two different types of symbol?

Answer- Symbols are of two types, namely verbal and nonverbal. Different words used to indicate substance, quality, action etc are called verbal symbols, for example books, honesty, come, etc. Different letters such as p, q, r, s etc or mathematical symbols such as +, -, $\div$, $\times$ etc are nonverbal symbols. The nonverbal symbols are used in symbolic logic.

24. Distinguish between sign and symbol.

Answer- Symbol & sign differ. It is not easy to draw a hard and fast line between the two. Sign may be natural or artificial but symbols are always artificial. Smoke is the sign of fire because there is natural and necessary relation between smoke and fire but symbol is that sign which is used consciously to indicate something. The national flag is a symbol of a nation. It is consciously designed. Symbols are predetermined artificial sign which is not always in the case of sign.

25. Distinguish between phonogram and ideogram.

Answer: Ideogram are those symbols which stands directly for concepts, for example multiplication sign 'X' and such other signs are ideograms. Ideograms are often contrasted with phonograms. Phonograms are signs which stands directly for sounds and indirectly for concepts, for example the written word 'multiplication sign' is phonogram. Unlike the ideograms the phonogram represents spoken English words which correspond to them while phonograms refer to the words in language which are written according to some sorts of phonetic rules, ideograms refers to the concepts or the ideas represented by the words.

26. What is truth function?

Answer:- A truth function is a compound expression where the value of the expression is determined by the value of the constituent variables the value of the statement or compound expression is determined as soon as the truth value of the constituent variables are known, for example the statement form $p \vee q$ is a truth function because the truth value of the expression is determined by the truth values of the two constituent variables p and q.

27. What is proposition?

Answer:- A proposition is a sentence or combination of sentence which is either true or false, for example Ram is a boy, $5 + 2 = 7$ etc. Similarly, Ram is not a boy, $5 + 2 = 10$ etc are propositions because the properties of truth and falsity can be meaningfully applied to such statements. On the other hand, a property of truth and falsity cannot be applied to the statement “do you know him?”, this statement is therefore is not a proposition.

28. . What are the two kinds of proposition?

Answer:- Propositions may be divided into two kinds, simple and compound. A simple proposition is one which consists of a single statement, for example you study hard, this can be symbolized as ‘p’. A compound proposition is one which contain two or more statements as component, for example Ram is a boy and Sita is a girl this is symbolically expressed as ‘p and q’. The following examples show the way in which various statements are joined and negated to form a compound propositions.

1. If you read then you will pass.
2. Either he will come or she will come.
3. You worked hard and you passed.
4. It is false that you worked hard. Now the meaning of the above propositions is ignored the symbol p and q are used for the first and second statement then the proposition can be symbolically expressed in the following way:

1. If p then q
2. Either p or q
3. p and q
4. not p

29. What is the nature of symbolic logic?

Answer- 1. Symbolic logic is a branch of logic. It is of recent origin. It is only about 180 years old as the first statement of symbolic logic as an independent branch appears in the books written by Augustus de Morgan and George Boole.

2. Symbolic logic is also concerned with the forms and validity of arguments like that of classical logic.

3. Symbolic logic uses symbols extensively because according to symbolic logicians, by use of spatial symbols validity or invalidity of arguments can be easily and clearly determined.

30. Distinguish between classical logic and symbolic logic.

Answer – 1. In classical logic symbols were used to a limited extent whereas in symbolic logic symbols are used extensively.

2. Modern logic clearly draws a distinction between inference and implication, in traditional logic this distinction was not clearly made.
3. Regarding the analysis of proposition in classical logic every categorical proposition is regarded to be the statement of certain relation between two terms. In modern logic, a proposition need not be two termed proposition.
4. The classical logicians thought that the capula alone is capable of expressing all types of relations. Modern logicians recognize various types of relations such as symmetry, transitivity etc.
5. Again regarding the classification of proposition the classical logic classify proposition into two types, namely categorical and conditional. Modern logicians in contrast, classified propositions into simple, compound and general. Further, on the basis of the idea of truth functionality, propositions are classified into tautologous, contingent and contradictory.

31. What are the characteristics of symbolic logic?

Answer- According to a distinguished American philosopher, C. I. Lewis the basic characteristics of symbolic logic are as follows:-

1. The use of symbols: The first basic characteristics of symbolic logic is the use of special symbol, for example '?' is ideogram but the written word 'question mark' is phonogram. It directly represents the spoken English which corresponds to it and not concept. According to symbolic logicians, the symbols have certain advantages, such as symbols bring out clearly the forms of arguments for which it become easier to divide arguments into valid and invalid.
2. The use of deductive method: The second basic characteristics of symbolic logic is the use of deductive method. In the deductive method from a limited number of statement we can produce an infinite number of other statements. Symbolic logic implies this deductive method and in this respect symbolic logic is quite close to mathematics.
3. The use of variables : The third basic characteristic of symbolic logic is the use of variables. Generally variable means changeable in logic variable is a symbol which can stand for anyone of the given range of value.

32. Write a note on importance of using symbols.

Answer- 1. The use of symbols exhibits the logical form of the argument and thereby helps to classify them according to their forms so that their validity can be determined through the application of general rules.

2. The use of symbols help to express the generality of the logical rules.
3. The use of symbols give conciseness, clarity and economy of expression to complicated statements and arguments which would be practically unintelligible when expressed in ordinary language.
4. The use of symbols help to express conveniently the concepts and technical terms which are peculiar to logic. Further symbols like variables are also useful to represent different logical operation.

5. The use of symbol helps to safeguard the argument from the influence of the material truth or falsity of the constituent proposition which create difficulties in the determination of its validity.

33. Why do you symbolize ordinary language?

Answer- An argument contain proposition as its premises and conclusion. Arguments as expressed in ordinary natural language are often difficult to appraise in their proper form on account of the vagueness and ambiguity of the words, the misleading idioms etc. With the view to resolve difficulties of ordinary language the logicians have introduced the artificial symbolic language. Hence, in symbolic language one important task is the symbolization of propositions and argument stated in ordinary language. In order to symbolize proposition and argument as expressed in ordinary language it is necessary to have a clear knowledge about proposition. However, it is also necessary to discuss clearly about the symbols- how and what type of symbols ought to be used, how proposition and their mutual logical relationships can be expressed adequately with the help of such symbols.

34. What points are to be noted about logical constants?

Answered- 1. Every compound proposition is formed by means of logical constants from simple propositions. The basic elements of any compound proposition, however complex are simple propositions and the logical constant form the compound proposition from the simple ones.

2. Every logical constants with exceptions of 'not' (negation) is known as logical connective because such logical constants form the compound propositions by connecting simple or other compound propositions.

3. Each connective connects two and only two propositions. 4. 'Not' or 'it is false that...' (negation) differs from other logical constants. Although it is a constant and extremely important one. It is not accepted as connective by some logicians that it does not serve to connect two propositions. But it is like other constant that it serves to form compound propositions from simple propositions by negating the simple proposition. In this sense, some other logicians accepted it as a connective.

35. Explain the truth functions of conjunction negation, disjunction, implication and equivalence.

Answer- The truth table of a compound proposition depends upon the truth value of a simple proposition out of which it is composed. The compound proposition is called a truth function of its component simple proposition for, the word or by which the simple propositions are joined together to form a compound proposition is called connective the words like 'and', 'not', 'either...or', 'if... then', 'if and only if' are propositional connectives.

The first type of connective Is conjunction. We can form the conjunction of two statements by placing the word 'and' between them. The statement so combined are called conjuncts. We produce '.' (dot) as our symbol for conjunction thus 'p' & 'q' any two statements whatever their conjunction is written as 'p.q'. The truth value of the conjunction of two statements is determined

wholly by the truth value of its two conjuncts there are only four possible cases and the truth value of the conjunction in each are as follows which is represented by means of a truth table –

p	q	$p \cdot q$
T	T	T
T	F	F
F	T	F
F	F	F

The negation or contradictory of statement is often formed by inserting a ‘not’ into the original statement. For negation we use the symbol ‘ $\sim$ ’ (curl). The negation of any true statement is false and the negation of any false statement is true now this fact can be represented by means of a truth table –

P	$\sim p$
T	F
F	T

A disjunctive truth function of proposition and compound proposition in which two propositions are joined together into one by the symbol ‘ $\vee$ ’ (vel). The two component statements so combined are called disjuncts. The Latin word ‘vel’ signifies inclusive disjunction and we use the letter ‘ $\vee$ ’. The word ‘vel’ signifies ‘or’ in this sense where p and q are any statement whatever, their inclusive disjunction is written as ‘ $p \vee q$ ’. This can be represented by the following two table:

p	q	$p \vee q$
T	T	T
T	F	T
F	T	T
F	F	F

A compound proposition can be obtained by the help of connective ‘if.... then’. A compound statement so obtained is called implicative function of the compound proposition. If p and q are two statements ‘if p the q’ is an implicative function of the truth table of p and q. For ‘if...then’ we use special symbol ‘ $\supset$ ’ (horseshoe) and thus ‘if p then q’ is symbolized as ‘ $p \supset q$ ’. The implicative function of $p \supset q$ is false when p is true and q is false. This can be represented by the following truth table –

p	q	$p \supset q$
T	T	T
T	F	F
F	T	T
F	F	T

An equivalent function is true only if p and q are either both true and both false otherwise it is false. $p \equiv q$ is an equivalent function. Here, there are two variables, so there will be four possible combinations of truth values its truth table may be regarded as the definition or formula of equivalent function . The tabular form of these:

p	q	$p \equiv q$
T	T	T
T	F	F
F	T	F
F	F	T

Unit-II

Construction of Truth Tables for Statement Forms

Decision Procedure: Testing of Validity/Invalidity by Truth Table Method

1. What is truth table method?

Answer- The method or technique in which the truth table are used to determine the validity or invalidity of an argument is called the truth table method.

2. What is it truth table?

Answer: Truth table is a convenient way to show the truth values of a truth function taking into consideration all possible truth values of a propositional variables involved in it. So the truth table is a definition of the truth function the compound sentence 'p and q' is called a truth function of its component sentences p and q because when we know the truth value of the compound sentence is thereby determined the tabular way of representing the dependence is called a truth table.

3. What do you mean by tautology or tautologous proposition?

Answer- The tautologous proposition is that kind of statement which is true under all conditions. The truth of such proposition is independent of any experience, for example he is a philosopher. The truth of the proposition can be known without any experience. The proposition is necessarily true. The statement form of tautologous proposition is ' $p \vee \sim p$ '. To show that the statement form is a tautology let us construct the following truth table:

p	$p \vee \sim p$
T	T T F
F	F T T

As there is only one variable so there are only two rows. In the conclusion column of this two table there is only T's this fact shows that all of the substitution instances are true that means this statement form is tautology.

4. What do you mean by contradictory proposition or contradiction?

Answer: A contradictory proposition is that kind of statement which is false under all conditions. The falsity of such proposition is also independent of any experience, for example, he is and is not a philosopher. The falsity of the proposition can be known by itself independent of any statement

form of contradictory proposition is $p \cdot \sim p$. To show that the statement form is contradiction let us draw the following truth table:

p	$p \cdot \sim p$
T	F
F	F

In the conclusion column of this truth table there is only F's. This fact shows that all of its substitution instances are false that means this statement form is contradiction.

5. What do you mean by contingent proposition?

Answer:- A contingent proposition is that kind of statement which is true under such and such condition. The truth or falsity of this kind of proposition is verified on the basis of experience only. Contingent proposition is not necessarily true, for example Ram is a boy and Romi is a boy. The truth or falsity of this proposition is not self-evident, experience can only prove that the statement form of contingent proposition is ' $p \cdot q$ ', ' $p \vee q$ ', ' $p \supset q$ ' etc. To show that this statement form is contingent, let us draw the table of the following :

p	q	$p \cdot q$
T	T	T
T	F	F
F	T	F
F	F	F

As there are two variables so there are four rows. In the conclusion column there are T&F both. This fact shows that this statement form is contingent as its truth value is dependent on its content rather than its form alone.

Unit-III

Proving Invalidity : Shorter truth table method, Indirect method

Q.1. What is shorter method of truth table?

Ans: A "shorter method" of truth table, often called the "short truth table method" or "indirect method," focuses on only checking the scenarios where the conclusion is false, working backwards from that point to see if it's possible to make all premises true while the conclusion is false; if so, the argument is invalid, essentially using a proof by contradiction approach to streamline the process compared to a full truth table.

Q.2. What is an indirect truth table?

Ans: In using the indirect truth table method in determining the validity of an argument, we aim to make the argument invalid. If it is possible for us to make the argument invalid, then obviously the argument is invalid. If it is impossible for us to make the argument invalid, then obviously the argument is valid.

SYMBOLIC LOGIC **THE SHORT TRUTH TABLE METHOD**

EXAMPLE 1:

$L \& Q$
 $\sim Q \supset K$
 K

STEPS TO EVALUATING VALIDITY OF AN ARGUMENT: Simplest Case

Case 1: One way to make the conclusion false

1. Construct a truth table with headings for the atomic sentences, sentence components, premises and conclusion.

				Premise 1	Premise 2	Conclusion
K	L	Q	$\sim Q$	$L \& Q$	$\sim Q \supset K$	K

2. Make the conclusion false by writing "F" in the top cell of the conclusion column of the truth table.

STRATEGY: Your strategy is to assume that the conclusion is false and then see whether it is possible for all the premises to be true (in the same row). This allows you to skip all rows in which the conclusion is true and focus on those in which it is false, making it easier to detect invalidity.

				Premise 1	Premise 2	Conclusion
K	L	Q	$\sim Q$	$L \& Q$	$\sim Q \supset K$	K
						F

Unit-IV

Formal Proof of Validity: Elementary rules of Inference

1. What do you mean by formal proof of validity?

Answer- A formal proof of validity for a given argument is defined to be a sequence of statements, each of which is either a premise or that argument or follows from preceding statements by an elementary valid argument and such that the last statement in the sequence is the conclusion of the argument whose validity is being proved. We first define an elementary valid argument as any argument is a substitution instance of an elementary valid argument form.

2. What is the formal way of writing out the proof or validity?

Answer- A more formal and more concise way of writing out this proof of validity is to list the premises and the statement deduced from them in one column with justification for the letter written beside them each case the justification for a statement specifies the preceding statements from which the rule of inference by which the statement in question was deduced this convenient to put the conclusion to the right of the last premises separated from it by a slanting line which automatically marks about it to be premises.

3. Illustrate an elementary valid argument.

Answer - Any substitution instance of an elementary valid argument form is an elementary valid argument thus, the argument

$$\sim C \supset (D \supset E)$$
$$\sim C$$
$$\therefore D \supset E$$

is an elementary valid argument because it is a substitution instance of the elementary valid argument form Modus Ponens (MP). It results from

$$p \supset q$$
$$p$$
$$\therefore q$$

But substituting ' $\sim C$ ' for p & ' $D \supset E$ ' for q therefore it is of that form even though Modus Ponens is not the specific form of the given argument.

4. Why are the 9 rules of inference called elementary valid argument forms?

Answer- The nine rules of inference are elementary valid argument forms whose validity is easily established by two tables they can be used to construct formal proofs of validity for a wide range of more complicated arguments. The names listed are standard for the most part and the use of their abbreviations permit formal proofs to be set down with a minimum of writing.

5. Why do we use the formal truth of validity?

Answer- If argument contains more than two or three different simple statements or components, it is tedious to use through tables to test their validity. More convenient method of establishing the validity of some argument is to deduce their conclusion from their premises by a sequence of shorter, more elementary of arguments that are already known to be valid. Consider, for example, the following arguments form in which there are five simple statements

$$A \vee (B \supset D)$$
$$C \supset (D \supset E)$$
$$A \supset C$$
$$\sim C$$
$$\therefore B \supset E$$

To establish the validity of this argument by means of a truth table would require a table with 32 rows.

We can prove the valid argument valid however by a sequence of just four arguments whose validity has clearly been established by using the rules of inference

1. $A \vee (B \supset D)$

2. $\sim C \supset (D \supset E)$

3. $A \supset C$

4. $\sim C / \therefore B \supset E$

5. $\sim A$ 3,4 MT

6. $B \supset D$ 1,5 DS

7. $D \supset E$ 2, 4 MP

8. $B \supset E$ 6, 7 HS

Rules of inference

1. Modus Ponens (MP)

$p \supset q$

p

$\therefore q$

2. Modus Tolens (MT)

$p \supset q$

$\sim q$

$\therefore \sim p$

3. Hypothetical syllogism (HS)

$p \supset q$

$q \supset r$

$\therefore p \supset r$

4. Disjunctive syllogism (DS)

$p \vee q$

$\sim p$

$\therefore q$

5. Constructive Dilemma (CD)

$(p \supset q) \cdot (r \supset s)$

$p \vee r$

$\therefore q \vee s$

6. Absorption (Abs)

$p \supset q$

$\therefore p \supset (p \cdot q)$

7. Simplification (simp)

$p \cdot q$

$\therefore p$

8. Conjunction (conj)

p

q

$\therefore p \cdot q$

9. Addition (Add)

p

$\therefore p \vee q$

Unit-V

Science & Hypothesis

Q.1. What is a Hypothesis?

Ans: A statement about a specific research question, and it outlines the expected result of the experiment.

Q.2. What do you mean by hypothesis?

Ans: A hypothesis is an educated guess or tentative explanation that can be tested to see if it's true. It's a starting point for further investigation or testing.

Q.3. What is the difference between a scientific theory and a hypothesis?

Ans: In scientific reasoning, a hypothesis is constructed before any applicable research has been done. A theory, on the other hand, is supported by evidence: it's a principle formed as an attempt to explain things that have already been substantiated by data.

Q.4. What is hypothesis ? Describe the nature of hypothesis.

Ans:- Hypothesis is an attempt at explanation of a provisional supposition made in order to explain scientifically some fact or phenomenon. Whenever we see something striking or unusual, we begin to guess out its explanation. A hypothesis is a provisional supposition which we make in order to explain some fact or phenomenon that needs an explanation. J. S. Mill puts forward a satisfactory definition as – “A hypothesis is any supposition which we make (either without actual evidence, or on evidence avowedly insufficiently) in order to endeavour to deduce from it conclusions in accordance with facts which are known to be real, under the idea that if the conclusions to which the hypothesis leads are known truths, the hypothesis itself either must be or at least is likely to be true”. To take an example of a scientific hypothesis. Newton saw an apple fall on the ground and supposed that it was due to the attraction of the earth. This supposition or hypothesis was subsequently proved to be true, and the Law of Gravitation was established.

Q.5. What is hypothesis ? What are the uses of hypothesis ?

Ans:- A hypothesis is an attempt at explanation of a provisional supposition made in order to explain scientifically some fact or phenomenon.

A hypothesis is an attempt at explanation :- A provisional supposition made in order to explain scientifically some fact or phenomenon. When ever we see something striking or unusual, we begin to guess out its explanation. For example :- If a man be attacked with cholera, we may suppose that he has probably taken impure water. So, we frame hypothesis to explain phenomenon.

The word ‘Induction’ is ambiguous and sometimes means the process and sometimes the product of the general proposition. If we regard Induction as a process of discovering and proving general propositions, we may state that hypothesis is the starting point of induction. Before a general law is discovered and proved, we must start with a provisional supposition as to what it might be and

this provisional supposition is hypothesis. In induction as a product of general proposition hypothesis is the first stage, when it is verified, it is raised to the status of induction.

Q.6.What is hypothesis ? What are the conditions of a legitimate hypothesis ?

Ans:- In our day – to – day life, we are constantly making suppositions to explain facts which come to our experience. Whenever we see something unusual, we begin to guess out its explanation. Thus we frame hypothesis to explain phenomenon. But we should remember that hypothesis is a provisional supposition made in order to explain some facts or phenomenon. So, a hypothesis is an attempt at explanation of a provisional supposition made in order to explain scientifically some fact or phenomenon.

The conditions of valid hypothesis are as follows :-

- i) The hypothesis must not be self contradictory or absurd but should be conceivable and definite.
- ii) The hypothesis must be free from conflict with establish truths. That means the supposition should not violate a law of which we have positive evidence.
- iii) The hypothesis must be based on facts and must have for its object a real cause or vera cause.
- iv) Lastly, the hypothesis must be verifiable.

Q.7. What is the use of hypothesis in scientific research?

Ans: Hypotheses are used to support scientific research and create breakthroughs in knowledge. These brief statements are what form the basis of entire research experiments. Thus, a flaw in the formulation of a hypothesis may cause a flaw in the design of an entire experiment.

Q.8.What is the role of a hypothesis in a scientific investigation answer?

Ans: A hypothesis is a possible answer to a question. It is based on: their own observations, existing theories, and information they gather from other sources. Scientists use their hypothesis to make a prediction, a testable statement that describes what they think the outcome of an investigation will be.

Q.9.What is the role of hypothesis in scientific Enquiry?

Ans:Hypothesis helps in making an observation and experiments possible. It becomes the start point for the investigation. Hypothesis helps in verifying the observations.

Q.10. Why is the hypothesis an important step in the scientific method?

Ans:Framing a hypothesis is crucial in science since it provides researchers with making an expectation and configuring trials to test it.

Anjana's