PHILOSOPHY (CBCS)

Semester-VI: DSE (UG)

Logic & Scientific Method

ASC

CLUSTER UNIVERSITY

****

UNIT – I

1. **Scope of Logic**
2. **Laws of Thought : (i) Law of Identity (ii) Law of Contradiction (iii) Law of Excluded Middle (iv) Law of Sufficient Reason**
3. **Deduction and Induction**

SCOPE AND DEFINITION OF LOGIC

The word "Logic" is derived from the Greek adjective "Logic" corresponding to the Greek noun "Logos" which means either thought or word as the expression of thought. The use of the same word "Logos" to denote both "thought and word" emphasizing the close relation between thought or its expression in language. Hence, etymologically logic is the science of thought, as expressed in language. Logic is a science of reasoning. Reasoning implies the process of passing from something given to something unknown. The given aspect of reasoning is known as the 'premise' or premises and the unknown which is ultimately discovered, is known as conclusion. In dealing with reasoning logic starts with 'proposition'. The proposition may be decomposed into terms which correspond to words in grammer. Thus, in dealing with reasoning, logic has to invariably deal with propositions and terms.

Aristotle, who is considered to be the father of Logic maintained that logic is a study of the forms of thought. Hamilton defines logic as the “Science of formal laws of the thought”.

According to the SextusEmpiricos, “Logic is a branch of Philosophy whose task is to find, ‘Trust worthy principles and methods for the discernment of truth”.

Arnauld defined Logic as “Science of the Understanding in the pursuit of truth”.

Wolf defined Logic as the study of the general conditions of valid inference for the proof.

According to Copi and Cohen, “Logic is the study of the methods and principles used to distinguish good (correct) from bad (incorrect) reasoning.

Jevons defined logic as the science of the formal or the Necessary laws of thought.

When we talk of the scope of a subject; we talk of the subject matter it studies and the problems it deals in. Logic has been defined as the science of the regulative principles of valid thought. Thus the Department within which logic carries on its enquiries is valid thinking. Valid thinking may therefore be said to constitute the scope of province of logic. The word thought means both the processes and the products of thinking. The process of thinking are conception, judgment and reasoning and the products of thinking are concepts. Judgments and Reasoning.As the subject matter of logic includes both the process and products of thinking. The scope of logic may be said to include both of them.

Validity or Truth may be formal or material and logic is concerned with both formal and material truth. Formal logic includes all forms of Deductive Reasoning and material logic includes all inductive Reasoning. Logic can be said to examine thought both in its formal and material aspects. Thus all these fall within the scope of logic.

LAWS OF THOUGHT

Logic is defined as the study of the laws of thought or the fundamental principles. Aristotle formulated three basic laws of thought, e.g., the principle or law of identity, the principle of contradiction and the principle of excluded middle. These principles or laws have been taken as the necessary and sufficient conditions for valid thinking.

The law of identity. This principle says that everything is what it is. Or in other words, if anything is "A", it is "A". That is to say, if any proposition is true, it is true. This law may seem to be a mere tautology. However, what it really means is that a thing must remain the same or unaltered throughout our discussion or thinking about the thing. The element of change or time has no place in deductive logical argument. We cannot descend into the same stream twice. If we admit that a certain thing has a certain meaning or attribute, then we must stick to it (admit it) always in the course of our thinking.

The law of contradiction. This principle asserts that nothing can be both "A" and 'not A" at the same time. In other words, no proposition can be both true and false at the same time. A thing cannot possess contradictory attributes. The two contradictory qualities cannot both be true of one thing. A piece of cloth cannot be both black and not black at the same time and place.

The law of excluded middle. This principle states that anything must be either "A" or "not A". That is, any proposition must be either true or false. The very nature of this law expresses the fact that there is not third or middle course; the answer must be "yes" or "no". If a piece of cloth is not black, it must be non-black.

Law of sufficient reason. Leibniz, 17th century German philosopher, propounded the law of sufficient reason,which states that whatever exists or is true must possess sufficient reason for being so and not otherwise. The principle expects that each true thought must be sufficiently substantaited which would mean that every event must have a cause and every proposition will have same logical grand for being a true proposition. Leibniz formulates his principle in the following few sentences.

i) Nothing comes to pass without reason.

ii) There must be a sufficient reason for anything to exist, for any event to occur, for any truth to obtain.

iii) Nothing occurs for which it would be impossible for someone who had enough knowledge of things to give a reason adequate to determine why the things is as it is and not otherwise.

DEDUCTION AND INDUCTION

There are two types of relationships necessary and probable between premisses and conclusion. Consequently, there are two types of reasoning and two types of logic:deductive and inductive. Though the nature of reasoning in both of them is different,their aim is none the less same. Both deductive and inductive logic provide methods and criteria to differentiate correct reasoning from incorrect ones.

The relationship between the premisses and the conclusion in deductive reasoning is of implication and "entailment". The implicative and "entailment" relationship justifies the assertion that the conclusion necessarily follows from the premisses in accordance with the logical principles. This is because the conclusion is already inherited in the premisses. For instances in the argument.

All men are mortal.

Socrates is a man.

Therefore, Socrates is mortal.

But very often the conclusion of an argument does not stand to the premisses in so necessary a logical relation as that of being implied or entailed by the premisses. Most of the reasoning that we do in everyday life is non-deductive (inductive). Doctors use non-deductive reasoning in diagnosing the probable causes of a patients symptoms. Legal scholars often

use non-deductive methods to determine what law governs in a particular case. Non-deductive or inductive arguments are tentative, provisional and probable.

There is nothing contradictory in accepting all true premisses and a false conclusion in non-deductive arguments. For instance in the following example.

Professor X is a writer and he is rich.

Professor y is a writer and he is rich.

Professor z is a writer and he is rich.

Therefore, all professors who are writers are rich,

All the premisses are true but the conclusion is false, and still it is not contradictory to accept the truth of the premisses and falsity of the conclusion. Thus the chief characteristic of deductive logic that it is impossible to have all true premisses and false conclusion is not applicable to the arguments of inductive reasoning.

A deductive logician never questions the status of the premisses; he does not bother whether the given premisses are actually true or false, Thepremisses are 'given' to him and he takes for granted their truth value and accept them as they are. The job of a deductive logican is merely to examine what necessarily follows from the 'given' set of premisses.The job of an inductive logician is two fold: first to collect the data(premisses) and second to establish a reasonably acceptable conclusion on the bases of collected data.

UNIT – II

1. **Proposition :** **Types of Proposition, Forms of Proposition according to quantity and quality (AEIO)**
2. **Syllogism :** **Types of Syllogism**
3. **Symbolic Logic :** **Negation, Conjunction, Disjunction, Implication**

PROPOSITION

A Proposition is a unit of reasoning in logic. Both premisses and conclusion of an argument are propositions. A proposition is a sentence, a meaningful arrangement of words. It has a subject, a predicate and a copula. Every sentence, however, is not always a propositions. Interrogative, exclamatory, emotive, or imperative sentences are not propositions.

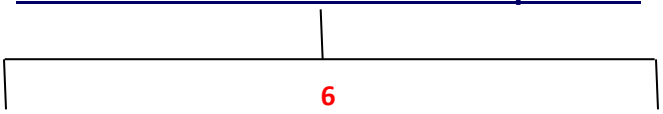
A proposition is true when it describes the facts correctly; and a proposition is false when it does not describe the facts correctly. One may believe a sentence to be either true or false. In this capacity the believed or disbelieved sentences become propositions, for they carry truth values.

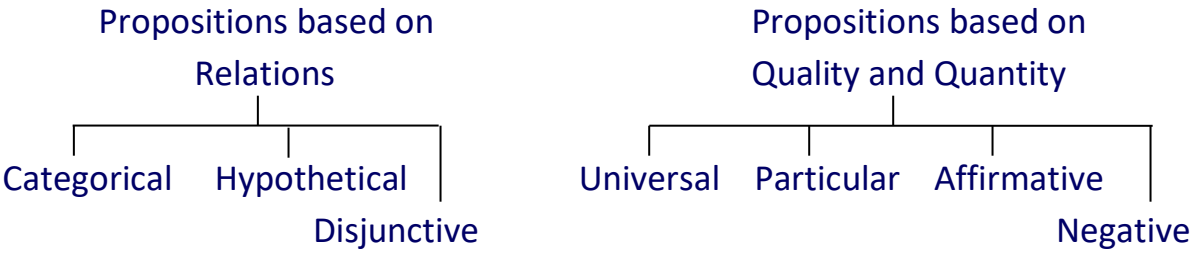
A proposition which is always true is called tautalogy in logic. For example, “The sum of all angles of a triangle is equivalent to 180”, “Cats are animals”, “No man is immortal”, etc. are tautologous propositions. A proposition which is always false is called contradictory or self-contradictory. For instance, “All men are immortal”, “All circles are polygon” are self-contradictory propositions. However, when a proposition is true in some cases and false in some other cases, it is called contingent. For instance, the proposition “It is raining” is true just now but may be false some other time.

Types of propositions

The Aristotlien or the traditional classification of propositions are as follows :-

Traditional Classifications of Proposition





Proposition based on Relations

1. **Categorical Propositions :-**

   In a categorical proposition, the relation between the subject and predicate is without any conditions for example

   All man are mortal (A)

   No man are immortal (E)

   Some men are wise (I)

   Some men are not wise (O)

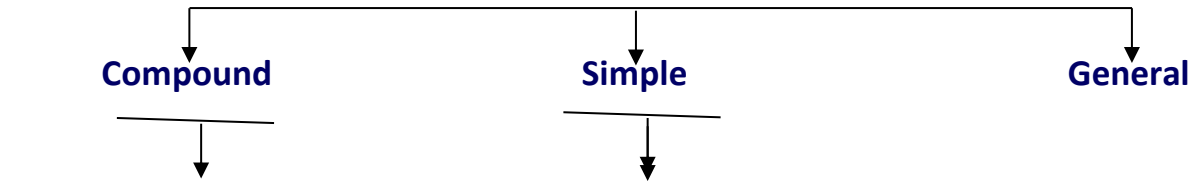
2. **Hypothetical Propositions :-**

   A hypothetical propositions has two parts, antecedent and consequent. The antecedent and consequent are combined by if-then. For example, "If he comes, then I shall go". 'If he comes' is antecedent and 'I shall go' is consequent.

3. **Disjunctive Propositions :-**

   A disjunctive proposition is also a conditional propositions which makes an alternative assertion. This type of proposition has two disjuncts 'either – or'. For example – "Either he will come or I shall go". Such a proposition asserts that at least one of the disjuncts is false.

Modern Classification of Propositions



(a) Conjunctive, (b) Alternative
(c) Conditional

(a) Subject Predicate, (b) Class membership;
(c) Relational

The analysis of propositions, in the traditional view, was restricted to the categorical propositions mainly. However, according to modern logic, logical relations hold between more varied and complicated forms of propositons. In modern logic, propositions are classified into the following categories:

A. *Compound propositions.* A compound proposition is a combination of two or more than two proposition. In other words, in a compound proposition, there are two or more than two statements, e.g Aristotle was both a great logician and a great political philosopher. This is a compound proposition. This proposition consists of two propositions: Aristotle was a great logician; and Aristotle was a great political philosopher. Compound propositions are further classified into the following categories.

(i) *Conditional propositions.* In a conditional propositions, the constituent statements are combined by 'if-then'. This type of proposition is also called hypothetical or implicative. For example, "if demand is changed (P), then price is changed (Q)," Here "demand is changed" is the 'antecedent' and "price is changed" is the 'consequent'.

(ii) *Alternative propositions.* An alternative proposition is a variety of compound propositions in which two or more constituent alternatives are combined by 'or' simply or by 'either-or.' For example, 'Either he will come (p) or I shall go (q)'.

Another type of proposition which is almost like an alternative proposition is known as disjunctive proposition. In a disunctive proposition, the statements are combined by 'not both' or 'either-or' or 'either-or but not both.' In a disunctive proposition, at least one of the disuncts is false. Both the disjuncts cannot be true at the same time; but both may be false. For example, He is not both single and marrried. Either he is single(p) or he is married (q) and he cannot be both.

(iii) *Conjunctive propositions.* A conjunctive proposition is a compound proposition in which two or more then two constituent propositions are combined by the conjunction 'and'. For example, "He will come(p) and I shall go"(q)" is a conjunctive proposition.

Simple propositions. A proposition is defined as a statement of a certain relation between two terms. If there is only one statement, the proposition is called a simple proposition. The subject of simple proposition is a singular term. Thus, simple propositions are also called singular propositions. Simple propositions can be further classified into following categories:

(i) *Class membership propositions.* In a class-membership proposition, it is asserted that some individual or object is a member of a class, i.e., "Aristotle is a logician." In this simple proposition, it is asserted that 'Aristotle' is a member of the class of logicians. This proposition asserts a relation which may be called a class-membership relation between Aristotle and the class of logicians.

(ii) *Relational propositions.* A relational proposition asserts a relation between at least two objects or individuals, e.g., "Hegel is the teacher of marx." Here, teacher-taught relation is asserted between Hegel and Marx.

(iii) *Subject-predicate propositions.* In a subject-predicate proposition, the property or the attribute is predicated of the subject. That is, the property or the attribute is predicated of the subject. That is, the property or the attribute denoted by the predicate is affirmed or denied of the subject. In other words, the property or the attribute either belongs to the subject or does not belong to the subject. This kind of proposition is, by definition, based on the relation between the subject and the predicate, e.g., "Ram is honest."

General propositions. General propositions assert the specific relation of inclusion or exclusion between classes. Propositions which deal with the relations between classes,i.e, with the total or particular inclusion or exclusion of one class in or from another, are called general propositions. In a general proposition, an assertion is made about all or some of the members of a class. For example, "all mathematicians are logicians" is a general proposition. The traditional categorical proposition A,E,I,O are all general proposition, because they assert either full inclusion or exclusion or partial inclusion or exclusion of one class in or from another.

Propositions based on Quantity and quality :-

From the point of view of quantity, propositions are divided into universal and particular. Both universal and particular propositions can be sub-divided into Affirmative and Negative, according to their quantity. On the bases of quantity and quality we have four forms of categorical prepostions.

PROPOSITIONS

(A) Universal

Affirmative e.g.
"All men are mortal"

Negative e.g.
"No men are perfect."

(B) Particular

Affirmative e.g.
"Some men are honest"

Negative e.g.
"Some men are not honest"

A universal affirmative proposition is represented by the symbol "A", a universal negative proposition by the symbol "E"; a particular affirmative proposition by the symbol "I", and a particular negative proposition by the symbol "O".

Thus, in a traditional fourfold classification, we get the following four propositions :-

A→ Represents universal affirmative proposition; e.g. "All men are mortal"

E→ Represents universal negative proposition; e.g. "No men are perfect"

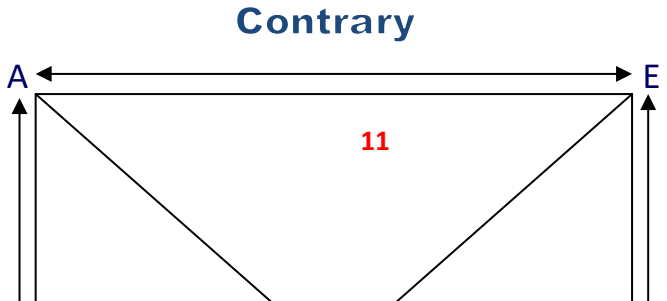
I →Represents particular affirmative proposition; e.g. "Some men are honest"

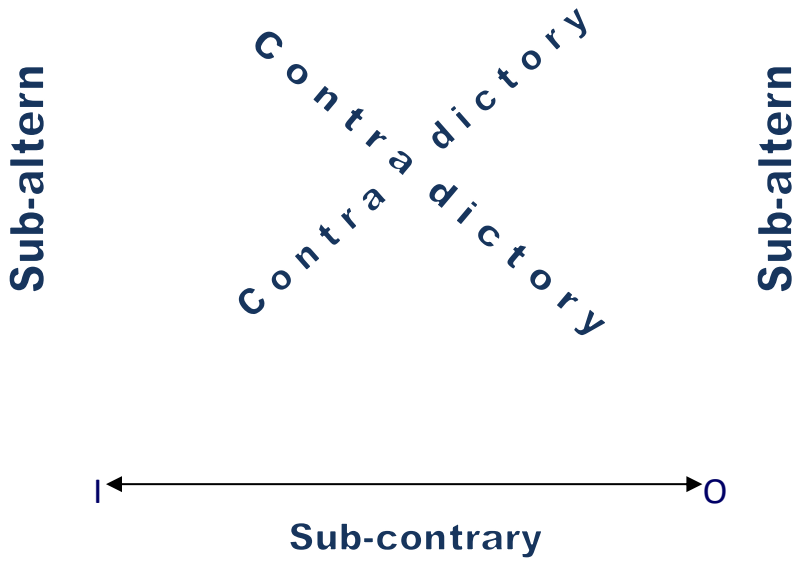
O→ Represents particular negative proposition; e.g. "Some men are not honest"

Square of Opposition

(i) Contradictories (ii) Cotnraries (iii) Sub Cotnraries ((iv) Sub alternation

In the system of Aristotelien logic, the square of opposition is a diagram representing the different ways in which each of the four kinds of propositions (A, E, I, O) of the system are logically related to each other.





Universal affirmative "A" proposition, "All S is P" and Universal negative "E" proposition, "No S is P" are related to each other by the Contrary relation. The proposition "All scientists are philosophers" is contrary to "No scientists are philosophers".

Particular affirmative "I" proposition, "Some students are scholarship holders" is related to "O" proposition "Some students are not scholarship holders" by subcontrary relation. Similarly, "O" proposition, "Some animals are not carnivorous" is related to "I" proposition, "Some animals are carnivorous" by subcontrary relation.

The Universal affirmative "A" proposition, "All S is P" is related to particular negative "O" proposition, "Some S is not P" by contradictory relation. The contradictory of "All men are mortal" is "Some men are not mortal" and vice versa. The contradictory of "E" proposition, "No crows are mammals" is "I" proposition, "Some crows are mammals".

The relationship among the categorical propositions is of opposites. Two categorical propositions are said to be opposite if they differ either in:

i. Quantity, or

ii. Quality, or

iii. Both quantity and quality

Contrary propositions “A” and “E” have same quantity (universal) but they differ in qualities. Similarly, subcontrary propositions “I” and “O” have same quantity (particular) but they differ in qualities. Propositions related by subaltern relationship such as “A” and “I”, and also “E” and “O” have the same quality but they differ in quantities. Contradictory propositions “A” and “O” and also “E” and “T”, however, differ both in quantities and qualities.

Each opposite relation has certain characteristics. Contrary proposition “A” and “E” cannot be both true together though they both can be false at the same time. If one of the contrary propositions I true then the other contrary proposition is necessarily false, whereas if one contrary proposition is false, the other contrary proposition is undetermined (it can be true or false).

Subcontrary propositions “I” and “O” cannot both be false together though they both can be true together. If “I” is true, “O” is undetermined; whereas if “I” proposition is false, “O” is necessarily true. Similary, if “O” is true, “I” is undetermined but if “O” is false, “I” is definitely true.

Subaltern relationship shows if “A” is true, then “I” is necessarily true, but if “I” is true, “A” remains undetermined. Same is the case with “E” and “O”. If “E” is true, “O” is true but not the other way round.

Contradictory relation between A” and “O”, and also between “E” and “I” is of strict opposition. If “A” is true, “O” is false, if “O” is true, “A” is false. Similarly, if “E” is true, “I” is false and if “I” is true, “E” is false.

SYLLOGISM

A Categorical syllogism is deductive argument in which a conclusions is inferred from two premises. There are only three propositions, two propositions and one conclusion. The conclusion in a syllogism must follow from the two propositions. The two given propositions are called premises.

In a syllogism, there are three term. Each of these terms is used twice, the subject of the conclusion is called the miner term (S), the predicate of conclusion is called major term (P) and the term which does't accrue in the conclusion is called the middle term (M)

e.g. All men are mortal
All kings are men
Therefore – All kings are mortal
Here the three terms are used 'men', 'mortal', 'kings'.

The Predicate term of the conclusion 'mortal' is major term, 'king' is the minor term and 'men' which does'toccure in conclusion is middle term.

The premiss which contains major term is called major premiss. The premiss which contain minor term is called minor premiss. Thus first premiss is major premiss, the second premiss is called minor premiss.

The middle term in a syllogism is very important. It provides a common bond or element on the basis of which a relation can be established between the major term and the minor term. The middle term is the link or means by which we can legitimately pass from the premises to the conclusion. The main characteristic of categorical syllogism is that all the three propositions (two premises and conclusion) are categorical proportions 'A', 'E', 'I', 'O'.

Rules for categorical syllogism :-

1. Every syllogism must contains three and only three terms.
2. A syllogism must consist of three and only three propositions.

3. The middle term must be distributed at least once in the premises.
4. No term can be distributed in the conclusion unless it is distributed in the premise.
5. From two negative premises no conclusion can be inferred.
6. If one premise is negative, the conclusion must be negative, and vice verse, i.e. to prove a negative conclusion, one premise must be negative.
7. If both premises are affirmatives, the conclusion is affirmative, as vice verse, i.e. if the conclusion be affirmative both premises must be affirmative.
8. If one premise is particular, conclusion must be particular.

Figure of Syllogism

The figure of a syllogism is the form of a syllogism as determined by the position of the middle term in the premises. The middle term occurs in both the major and the minor premises, but the position of the middle is not the same in all syllogisms. The middle term may either be the subject or the predicate. The middle term has four possible positions. Depending on their four positions, there are four figures of syllogism.

First Figure,

M P
S M
Therefore S P

In the first figure, middle term is subject in the major premise and predicate in the minor premise.

Second Figure,

P M
S M
Therefore S P

Middle term is the predicate in both the premises in the second figure.

Third figure,

M P
M S
Therefore S P

Middle term is the subject of both the premises in the third figure.

Forth Figure,

P M

M S

Therefore S P

Middle term is the predicate in the major premise and subject in the minor premise in the forth figure.

Moods of syllogism

The mood of a syllogism is the form of a syllogism as determined by the quantity and quality of the constituent proposition. Propositions are classified A,E,I and O, on the basis of quantity and quality (affirmative and negative imply quality, while universal and particular imply quantity). The mood of a syllogism is expressed with the help of a combination of three types of propositions out of four.

e.g. No heroes are cowards (E)

Some soldiers are cowards (I)

∴ Some soldiers are not heroes (O)

The major premiss is an 'E' proposition, the minor premiss is an 'I' proposition and the conclusion is an 'O' proposition. Hence the mood of that syllogism is EIO.

All man aremartal (A)

All kings are men (A)

Therefore All kings are martal (A)

In this syllogism, the mood is AAA, because all the three proposition here are of the type A (Universal affirmative).

There are 256 possible moods with different combination of categorical proposition in all the four figures of syllogism. Out of them only 15 moods are valid which are as follows :-

I Figure – AAA, EAE, AII, EIO

II Figure – EAE, AEE, EIO, AOO

III Figure – IAI, AII, OAO, EIO

IV Figure – AEE, IAI, EIO

Symbolic logic

Meaning of symbols used

Symbols	**Meaning**
⊃	If then / Implies
.	And
v	Either – or / or
~	Negation
≡	Equivalent
p, q, r	Any proposition

Logic is defined as a science of correct inference. It is a science which gives us knowledge of the principles, methods and techniques with which we can distinguish between correct and incorrect inference. Aristotle, who is known as the founder of logic, has discovered the fundamental rules of correct inference in the fourth century B.C. Modern symbolic logic is a development of principles, concepts and techniques which was implicit in the work of Aristotle. The advantages of using symbols in logic are the same as in mathematics, symbols are easier to manipulate, they provide an economical shorthand, and they allow us to see at a glance the overall structure of a sentence. By using symbols, we are able to deal with much more complicated arguments. The aim of symbolic logic is two fold – first to symbolize the arguments and expressions and secondly to evaluate them.

The Symbols for Negation, Conjunction, Disjunction, Implication and Equivalence.

Negation :-The negation of a statement is often formed by insertion of a 'not' in the original statement. Symbol " ~ " (called a curl or tilde). The curl is a truth functional operator. The negation of any true statement is false and the negation of any false statement is true.

Truth Table

P	**~P**

T	F
F	T

The truth table shows that ~P is false when P is true and ~P is true when P is false. ('T' for Truth and 'F' for false)

Disjunction :-The disjunctionof two statements is formed by inserting the word "or" between them. The two combined statements are called disjuncts and "or" is represented by the symbol 'v' called wedge.

Truth Table

P	**q**	**Pvq**
T	T	T
T	F	T
F	T	T
F	F	F

The truth table indicates that the disjunction is true when at least one of the disjuncts is true and that otherwise it is false.

Equivalence :-Two statements are said to be materially equivalent, or equivalent in truth value, when they are either both true or both false. This notion is expressed by the symbol ≡. It is a compound proposition in which two simple propositions are connected to each other with the connective 'if and only if….'

Truth Table

P	**q**	**P ≡ q**
T	T	T
T	F	F
F	T	F
F	F	T

Hence the symbol "≡" may be read "if and only if".

The truth table shows that the equivalence is true when its two components have the same truth value and that otherwise it is false.

Conjunction :-We can form the conjunction of two statements by placing the word 'and' between them; the two statements so combined are called conjuncts. A conjunction is a truth functional compound statement, so dot (.) symbol is a truth functional connective. Any two statements, P and q, there are only four possible sets of truth value they can have.

Truth Table

P	q	P.q
T	T	T
T	F	F
F	T	F
F	F	F

This truth table shows that a conjunction is true when its two conjuncts are true and is false in all other cases.

Implication (Conditional) :- Conditionalstatements having general form of "if – then" where the component statement that follows the "if" is the antecedent and the component statement that follows the "then" is the consequent. The horseshoe, " ⊃ ", representing the truth functional connective. If P than q will be symbolized as ; P ⊃ q, which may be read simply as P implies q.

Truth Table

P	q	P⊃q
T	T	T
T	F	F
F	T	T
F	F	T

The truth table shows that a conditional statement is false when the antecedent is true and the consequent false and is true in all other cases.

UNIT – III

1. **Scientific Method : Hypothesis**
2. **Scientific and unscientific explanation, Evaluating Scientifc Explanations**
3. **Fallacies of Relevance and ambiguity**

SCIENTIFIC METHOD: - HYPOTHESIS

SCIENTIFIC AND UNSCIENTIFIC EXPLANATION

In any scientific investigation, the scientist begins by assuming some possible explanation for the problem he is investigating.This possible explanation is called hypothesis. Using this as a starting point of his investigation, he proceeds further to collect facts through observation and experiments. If our empirical evidences support the hypothesis, then the hypothesis is accepted as correct explanation, otherwise not. A hypothesis thus is merely a tentative or provisional solution to a problem. It is not the real solution of the problem (for which the hypothesis is constituted), till verified.

A hypothesis is important for a proper and systematic scientific investigation. It points to the direction in which the scientist should make observations and conduct experiments. By framing hypothesis the research is focused on specific points and the entire energy (experiments and observations) is used to gather the evidences in favour of the hypothesis. Random investigations are of no help and only an organized investigation is fruitful. Hypothesis defines the scope of a scientific inquiry and helps in saving time and efforts of the investigators. The hypothesis serves as the starting point in the rigorous scientific research and thus a hypothesis is assumed as a guide to scientific inquiry. All scientific investigations start with the formulations of hypothesesand stop with their verification and proof. Historians, detectives, social scientists as well as natural scientists make extensive use of hypothesis.

A hypothesis is simply a suggestion or a possible explanation of a particular phenomenon. It is merely a suggestive, tentative or a provisional

solution to a problem. A hypothesis is not the real solution until tested and verified. All hypotheses are subject to revision, modification or even rejection.

The main characteristic of a “good”, “valid” or “legitimate” hypothesis is that it should explain facts around us; it must be based on events actually occurring in nature. Valid hypothesis depends on facts in its origin and also for its verification. Another important quality of a “good” hypothesis is that it should be verifiable with reference to observation or experience. The verifiability of a hypothesis can be done directly or indirectly. A hypothesis which lacks any verification (direct or indirect) is called "barren hypothesis”, and is not for the scientific inquiries. Besides verifiability and having approved by actual experiences, a good hypothesis must satisfy other conditions too. A hypothesis should be purposeful, and directed to solve the problem for which it is framed. Random or irrelevant hypotheses cannot be considered for serious discussions in sciences or in ordinary common life. Moreover, the hypothesis must be clearly and distinctly conceivable in itself. It should be stated in the clearest of terms. The vague, obscure and ambiguous hypothesis will only compound the problem of the scientist instead of solving it.

A working hypothesis is to be tested and verified. Without verification a hypothesis can never be accepted as the real solution to the problem.

Evaluating Scientific Explanations

Verification of a Hypothesis

Verification of a hypothesis means testing of the truth of the hypothesis in the light of actual facts and in the context of empirical data. The process of verification involves a comparison between the conclusion deduced from the hypothesis and facts gathered through observation. The greater the agreement between the inferences derived from the hypothesis and facts gathered through observation or experience, the stronger will be the evidences in favour of confirming the hypothesis. Verification means to

find out whether the conclusion derived from the hypothesis is supported by the actual experiences or not.

Verification of a hypothesis is of two types:

1. Direct.
2. Indirect.

Direct Verification: Direct verification is done by direct appeal to experiences and observation. In many cases direct verification of hypotheses is not possible. In those cases indirect verification and indirect evidences are looked for to verify the hypotheses. In indirect verification the consequences are deduced from the hypothesis (the one which one wants to verify) and they are then compared with the actual facts. If the deduced consequences or evidences agree with the facts actually observed, then the hypothesis is verified, otherwise it stands rejected.

Indirect verification of a hypothesis is done by constructing a logical argument. If expressed in the strict logical form it becomes a hypothetical syllogism. Suppose one wants indirect verification of a hypothesis, say, H, then one will frame hypothetical syllogism as follows:

If the fact S is observed, then the hypothesis H is true.

S is observed.

Therefore, the hypothesis H is true.

Take a concrete example:

If the roads are wet, then it has rained recently.

The roads are wet.

Therefore, it has rained recently.

Scientists, detectives and historians use direct as well as indirect verification to justify and verify their hypothesis.

FALLACIES

Fallacies of relevance and ambiguity

Fallacy is an error in reasoning; it is a mistake in judgment. An argument is governed by certain rules, and violation of any one of them makes the argument invalid and fallacious. Sometimes incorrect argument deceptively appears to be correct but on the examination is found incorrect. The aim of a logician is to provide methods to differentiate correct reasoning from incorrect one.

Fallacies are divided into two categories: -

1. Formal Fallacies.
2. Informal Fallacies.

Formal Fallacies

A formal fallacy is committed when the argument has faulty structure or form. Formal reasoning such as syllogism, if it violates any of the rules of the valid categorical syllogism, then it commits the formal fallacy.

Informal Fallacies

Informal Fallacies are divided into three categories. They are: -

1. Fallacies of Ambiguity
2. Fallacies of Relevance
3. Fallacies of Presumptions

Fallacies of Ambiguity

Fallacies of Ambiguity arise from the loose and mistaken ways in which words and sentences are used in arguments. Since arguments are expressed through language, there can be many ways in which errors could arise. It

could be either due to wrong use of words or due to wrong construction of statements. Accordingly there are many fallacies of Ambiguity. Some of the main fallacies in this category are : -

1. Fallacy of Equivocation: - The Fallacy of Equivocation occurs when same word or a phrase is used with two meanings.
2. Fallacy of Amphiboly: - The Fallacy of Amphiboly occurs when the construction of statement allows it to have more than one meaning.
3. Fallacy of Accent: - The Fallacy of Accent occurs when one distorts the meaning of a statement by wrongly emphasizing some part of it.
4. Fallacy of Composition: - The Fallacy of Composition occurs when the conclusion is drawn from the attributes of the parts of a whole to the attributes of whole itself.
5. Fallacy of Division: - The Fallacy of Division occurs when the attributes of its parts are drawn from the attributes of whole.

Fallacies of Relevance

Fallacies of relevance are committed when the premises of an argument are found irrelevant to the conclusion for one reason or the other. The premises appear to be relevant to the conclusion but on the close examination are found either inadequate or incomplete. The premises may appear to be psychologically relevant but for a sound argument premises should be logically and not psychologically relevant. The premises can be irrelevant to the conclusion in various ways and, therefore, there are many fallacies in this category. The main fallacies are: -

1. The Appeal to emotion (Argument Ad Populum): - The fallacy occurs when an argument is supported by emotions and not by reasoning.

2. The Appeal to pity (Argument Ad Misericordiam): - The fallacy occurs when one is asked to agree with the arguer on the basis of his pitiable conditions.
3. The Appeal to force (Argument Ad Baculum): - the fallacy occurs when an argues threatens his opponent with unpleasant consequences if his viewpoint is not accepted.
4. The Argument from ignorance (Argument Ad Ignorantiam): - The fallacy occurs when the absence of proof assures the non-existence of fact and absence of disproof assumes the existence of facts.
5. An Appeal to inappropriate authority (Argument Ad Verecundiam): - The fallacy occurs when 'cited authority' falls short of credibility.
6. The Argument against a person (Argument Ad Hominem): - The fallacy of argument ad hominem is committed in the following manner. Person A makes an argument. Person B evaluates that argument. Person B shows that the argument made by A is wrong because either.
    i. Person A carries a bad reputation and hence his argument cannot be sound or
    ii. Person A's circumstances are questionable hence his argument cannot be sound.
7. Fallacy of Accident: - The fallacy occurs when a general rule is applied to a particular case in which 'accidental circumstances' make the rule inapplicable to it.
8. The Fallacy of converse accident: - The Fallacy occurs when we pass from a statement which is true in certain special circumstances to a statement which is supposed to be true under all circumstances.
9. Fallacy of False cause (Non-causa pro-causa): -The Fallacy occurs when a non-casual event is assumed to be either a cause or part of a cause of an effect.

10. Irrelevant Conclusion (IgnoratioElenchi): - The Fallacy occurs when the premises do not imply the conclusion which they are supposed to, and instead they imply something else.

Fallacies of Presumption

Following are the two main fallacies of presumption.

1. Begging the question (PetitioPrincipii): - The Fallacy occurs the conclusion or part of the conclusion is stated in the premise either explicitly or in a slightly different form.
2. Complex Question: - the Fallcy occurs when a question is asked in such a manner as to assume (presuppose) the truth of some facts hidden in it.

UNIT – IV

1. **Mills Methods**
   - i. **Method of Agreement ; Difference**
   - ii. **Method of Concomitant variation**
   - iii. **Method of Residue**

MILLS METHODS

To discover a causal relation among facts is the primary aim of a scientist. The crucial question now is how to discover a causal relation? How do we know that A is the cause of B? How does a scientist arrive at the conclusion that the certain conditions, say, X is the cause of Y phenomenon?

The logicians believe that there are methods which help in revealing the causal connections in the nature. Francis Bacon, in the sixteenth century, was the first such logician who emphasized in the efficiency and sufficiency of these methods.

The methods of discovering causal relationships though were first suggested by him, but it was J.S. Mill who formulated and elaborated them systematically in the nineteenth century'. He (Mill) clearly defined these methods and highlighted their importance in scientific investigations.

The experimental methods given by him are as follows:

1)Method of Agreement

2)Method of Difference

3)Joint Method of Agreement and Difference

4)Method of Residues

5)Method of Concomitant Variation

Method of Agreement

The method of agreement is the most popular of all the experimental methods. It is used by common men, scientists and philosophers alike. The basis of the method of agreement is the occurrence of a certain phenomenon repeatedly. In our experiences we observe some facts occur simultaneously. Whenever one say A occurs, another fact say *a* also occurs. The togetherness of two facts A and *a* leads human beings to relate them casually.The human mind becomes so accustomed and conditioned by observing togetherness of the two facts that next time whenever one sees A event, he expects *a* to follow. The strength of the method of agreement depends on the large number of instances. The greater are the instances, the more reliable is the causal relation.

Method of Difference (Disagreement)

The method of difference can be applied to almost all those cases where the method of agreement is applied. But whereas the method of agreement requires large number of instances, the method of difference needs just two. The two instances should be such that they resemble each other in every respect except one. For instance, if a bell is rung in a jar filled with air, the sound of the bell is heard, but if the same bell is rung in ajar from which the air has been pumped out, no sound is heard (provided other circumstances remain the same). From this, one concludes that the presence of air is an indispensable part of the cause of sound.

Joint Method of agreement and Difference

Since the method of agreement and the method of difference are applied to the same cases, the investigator may sometimes use both of them to establish a causal relation. The simultaneous application of twin methods increases our faith in the conclusion drawn from the evidences. The join method thus is certainly superior than the method of agreement alone or the method of difference alone.

Method of Concomitant Variation

In order to determine the causal relation the irrelevant circumstances are systematically eliminated. But there are circumstances which cannot be eliminated altogether. For instance, heat, gravity, atmosphere, friction, pressure, etc. are the natural necessities which cannot be eliminated altogether.

Though the complete elimination of these permanent causes is not possible, yet they vary in degrees and through the method of concomitant variation one can establish the casual relationship between them.

Mill states the method of concomitant variation as: "whatever phenomenon varies in any manner whenever some other phenomenon varies in some particular manner is either a cause or an effect of that phenomenon or is connected with it through some fact of causation.

Method of Residues

Mill defined the method of residues as follows:

"Sub-duct from any phenomenon such part as is known by previous inductions to be the effect of certain antecedents, and the residue of the phenomenon is the effect of the remaining antecedents."[6]For instance, in order to know the weight of the cargo the usual practice is to weigh empty truck and then to weigh loaded truck of cargo. The difference between the weights is the actual weight of the cargo. Here the method of residues is applied, and except this method there is no other way to weigh the cargo.

Many times at a grocer's shop you would have noticed that the shopkeeper first weighs an empty container and then he weighs container again after filling it with ghee or oil. This is yet another illustration where the method of residues is applied.