BUREAU'S

HIGHER SECONDARY (+2)

LOGIC

PART - II (SECOND YEAR)

Approved by the Council of Higher Secondary Education, Odisha

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FOREWORD

The Council of Higher Secondary Education, Odisha has restructured the syllabus in Logic for its Examination 2018 and onwards. As usual the Bureau is going to publish Textbook in Logic entitled Bureau's Higher Secondary (+2) Logic in two parts in conformity with the new syllabus. It has been prepared by a team of experienced and eminent teachers of the State selected by the Council.

This new edition has been prepared according to the revised syllabus of CHSE, Odisha. I am thankful to Prof. Dhaneswar Sahu, Prof. Durga Madhab Praharaj, Dr. Kailash Chandra Dash, Sri Niranjan Padhi, Sri Basant Kumar Dash, Dr. Bhaskar Ch. Sahoo and Dr. Susant Kumar Pattnaik for undertaking the revision work of the book.

It is hoped that this book will fulfil the aspirations and cater to the needs of the students and teachers of the State. Comments and suggestion on any aspect of this book will be highly appreciated by the Bureau.

Sri Umakanta Tripathy
Director
Odisha State Bureau of Textbook
Preparation and Production
Pustak Bhavan, Bhubaneswar.

PREFACE

This book has been written to serve as a text book in logic for the 2nd year of the +2 Course of the Council of Higher Secondary Education, Odisha. A chapter on Indian Philosophy & Indian Ethics has been incorporated keeping in view the syllabus prescribed by the Council. It covers the entire syllabus, and also has some additional materials for advanced students who may wish to know more about the subject. Since the study of logic aims to develop our skill in correct reasoning, it is best studied by doing logic. Keeping this in mind exercises have been provided at the end of every chapter. Students are well advised to workout the objective-type questions in the exercises of a chapter before proceeding to study the next chapter.

In conformity with the standard practice adopted in most of the text books the terms 'disjunction' and 'disjunctive' (in disjunctive proposition) have been used in this textbook to signify the inclusive sense of 'either ... or ...'. We have used the term 'alternative' (as it occurs in 'alternative proposition') to signify the exclusive (stronger) sense of 'either ... or ...'. Further, the account of contraposition as a form of immediate inference provided in this book conforms to that provided in standard textbooks in logic. On these two points some logic textbooks give different account. We hope that for the sake of accuracy and uniformity such changes will be incorporated in those textbooks in the near future.

The authors are thankful to the authorities of the Odisha State Bureau of Textbook Preparation and Production for this assignment. Suggestions from teachers and students for improvement and correction of mistakes are welcomed. The authors will be amply rewarded if the book is found useful by the teachers and students of logic.

Board of writers

Courses of Studies

2nd year (+2) Logic

Unit 1 : The Theory of Inference : Classification of Inference, Conversion, Obversion

Categorical Syllosism : Structure, Figure, Moods. Rules of syllogism, Determination of Valid Moods.

Unit 2 : Special rules of Figures, Aristotle's Dictum, Direct and Indirect Reduction.

Mixed Syllogism : Different forms - Hypothetical categorical, Alternative Categoical, Disjunctive Categorical, Dilemma: Forms, Refutation, Rebuttal of Dilemma.

Unit 3 : Fallacy :Deductive Fallacy, Semi-logical Fallacies, Inductive Fallacies : Fallacy of Illicit Generalisation, False Analogy, Ignoratio Elenchi.

Propositional Logic : Symbolic Logic and its Characteristics, Propositional Variables, Logical Constants, Propositinal Connectives, Truth Functions, Construction of Truth Tables, Testing Validity by direct Truth Table Method.

Unit 4 : Methods of Experimental Enquiry: Mill's Five Experimental Methods.

Scientific Explanation: Nature of Scintific Explanation.

Unit 5 : Nyaya Theory of Knowledge :Perception and Inference: Vyapti and its ascertainments.

Doctrine of Karma : Niskama Karma of Bhagavad Gita, Gandian Concept of Non-Violence.

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CHAPTER - 1
THE THEORY OF INFERENCE

1.1 Classification of Inference :

In part I of this book, we have discussed the nature and kinds of arguments and we have said that logic is concerned with appraisal of arguments. It distinguishes good arguments from bad ones by identifying the principles of good arguments. An argument is otherwise known as inference. Some textbook writers of logic make a distinction between inference and arguments by holding that the inference is a mental process and is only for oneself, while an argument is a verbalized inference. In other words, when an inference is expressed in language it is called an argument. It is always used to convince others. By looking at the logicians' use of the terms "inference" and "argument", we find that the above distinction has no substance. In general, logicians use these two concepts interchangeably. We also follow the same convention and hold that the argument is otherwise known as inference.

Inference is a sequence of propositions where one of the propositions is identified as the conclusion and the rest of the propositions are called premises such that premises justify or support the truth of the conclusion. In other words, an inference is a relation between premises and the conclusion. The aim of logic is to characterise the nature of this relation. At the outset, on the basis of this relationship we classify all inferences into two types, namely, inductive and deductive. An inductive inference is a kind of inference where the conclusion is not conclusively justified by the premises. Moreover, its aim is to make a generalization on the basis of uncontradicted experiences of observation of finite (or limited) number of cases. The set of premises of any inductive inference must be finite and are based on the uncontradicted

experiences. The conclusion is just the generalization of such uncontradicted experiences and thus is always probably true." The form or structure of an inductive inference is :

Each of a_1, a_2 ..... a_n has been observed to be S is P.
Nothing has been observed to be S without P.

Therefore, probably all S are P.

The detail discussion on inductive inference, its classification, nature etc.have been done in the portion on inductive logic. In the present work our aim is to study only deductive inferences.

Deductive inference is a kind of inference where the truth of the premises conclusively support or justify the truth of the conclusion. In a valid deductive argument it is impossible for the premises to be true and the conclusion to be false. Deductive arguments are primarily of two types depending upon the number of premises the argument contains. These arguments are either immediate or mediate. An immediate inference is a type of deductive inference in which the conclusion is derived from exactly one premise. This type of inference is called immediate because there is no other premise existing between the initial premise and the conclusion. Or it can be described as an inference where the conclusion is obtained without the use of a middle term. (The notion of middle term will be explained in the next chapter)

For example,

All men are mortal. (Premise)
Therefore, some mortals are men. (Conclusion)
It is an instance of immediate inference.

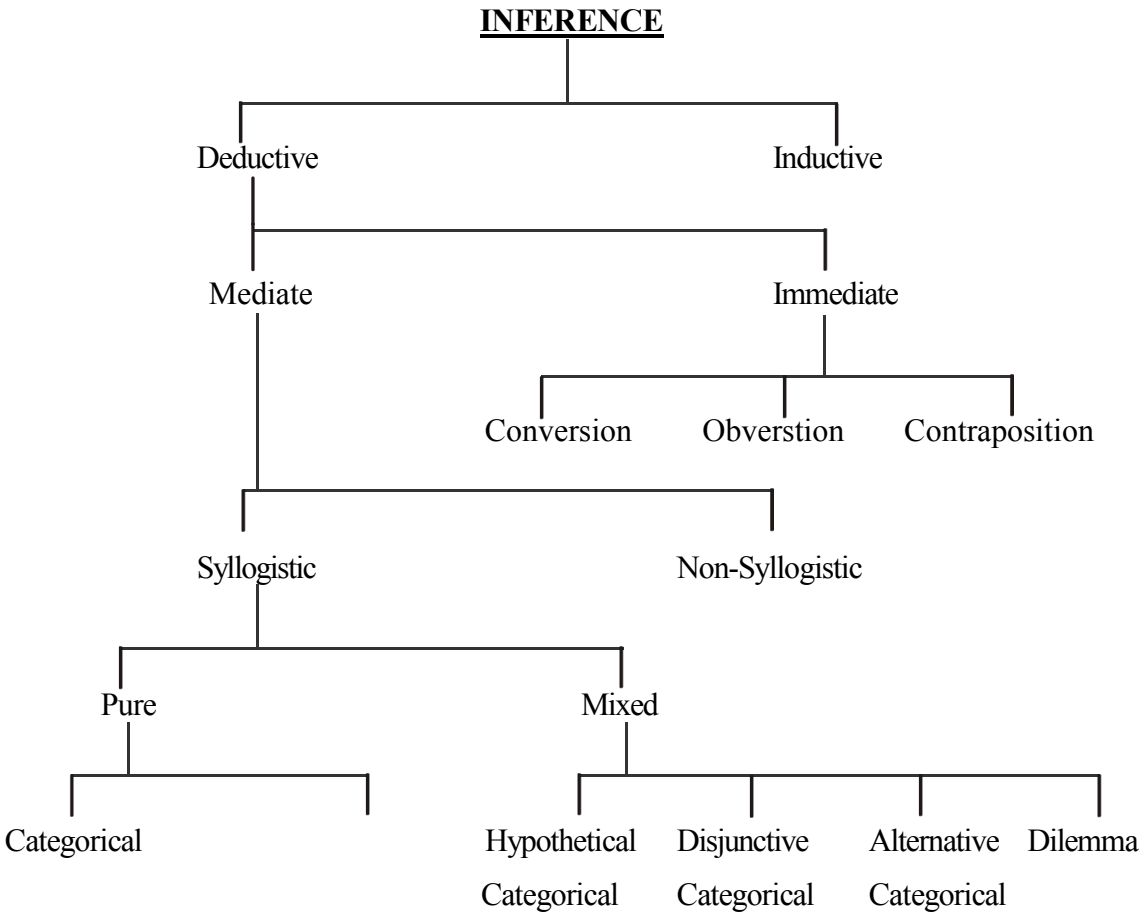
Immediate inferences are mainly of three types namely (i) Conversion, (ii) Obversion, and (iii) Contraposition. Each of these will be studied in detail in the present chapter. On the other hand, a deductive inference is called mediate if the conclusion is obtained or derived by use of more than one premises. It is of two types (i) Syllogistic and (ii) Non-Syllogistic. An inference is called syllogistic if and only if the conclusion is derived from two premises taken

jointly. In this case, the number of premise are exactly two and it is essential to use both the premises to obtain the conclusion. For example,

All men are mortal.	Premise
All kings are men.	Premise
Therefore, all kings are mortal.	Conclusion.

Here, the conclusion cannot be derived if we do not jointly consider these two premises. A mediate deductive inference is called non-syllogistic if the conclusion is derived from more than two premises. In this case we do not have the restriction to use all the premises jointly to derive the conclusion, unlike syllogistic inference.

Further, syllogistic inferences are again of two types, namely pure and mixed. If all the propositions, including the premises and the conclusion are of one type it is called pure and if it contains different kinds of propositions it is called mixed syllogism. Pure syllogisms are again of two types, namely (i) Categorical and (ii) Hypothetical. If all the propositions in a syllogism are categorical, it is called categorical syllogism. On the other hand, if all the propositions in a syllogism are hypothetical propositions, it is called pure-hypothetical or hypothetical syllogism. Mixed syllogisms are of four types namely, (i) Hypothetical-categorical, (ii) Disjunctive-categorical and (iii) Alternative-categorical (iv)Dilemma. Hypothetical-categorical syllogism is a kind of syllogism where the major premise is hypothetical, the minor premise is categorical and the conclusion is categorical. A disjunctive-categorical syllogism is a mixed syllogism where the major premise is disjunctive and minor premise is categorical and the conclusion is also categorical. So also in alternative-categorical syllogism the major premise is alternative and minor premise is categorical and conclusion is categorical propositions. Similarly, dilemma is a kind of mixed syllogism consisting of a compound hypothetical proposition as its major premise and its minor premise is a disjunctive proposition leading to a categorical or disjunctive proposition as its conclusion. For convenience we give below the various kinds of inferences in a tabular form.



Before discussing different types of immediate inferences, it is essential to discuss the general principles of distribution, as it holds good with respect to immediate and mediate inferences in general.

The Principle of Distribution :

The principle of distribution states that in any deductive inference, if a term is distributed in the conclusion, then it should have been distributed in the premise. Alternatively, no term should be distributed in the conclusion unless it is distributed in the premise. This principle is a valid principle of deductive logic. To see its validity, let us argue as follows. Assume that the principle of distribution is not valid. Then there exists an argument in which a term say 't' is

distributed in the conclusion but not distributed in the premise. Then by the definition of distribution, 't' is taken in its entire denotation in the conclusion, while only the part of the denotation of 't' is being considered in the premise. Therefore, the conclusion states more than the premise contradicting the notion of deductive inference. Hence, the principle of distribution must be valid. Now, we will discuss various types of immediate inference namely (i) Conversion, (ii) Obversion, (iii) Contraposition.

1.2 Conversion :

Conversion is a kind of immediate inference. It has one premise and a conclusion. The premise of conversion is called convertend and the conclusion is called converse. In other words, the proposition to which conversion is applied or the proposition which is to be converted is called convertend and the result or the conclusion is called converse. We may define conversion as a kind of immediate inference in which the subject and predicate terms of the convertend are interchanged, the quality of the converse is same as that of the convertend and also it satisfies the principle of distribution (i.e. no term is distributed in the converse unless it is distributed in the convertend.) An immediate inference satisfying the following rules (or conditions) is called conversion.

i. The subject and the predicate terms of the convertend interchange their position in the converse. This means that the subject term of the convertend becomes the predicate of the converse and the predicate term of the convertend becomes the subject of the converse.

ii. The quality of the converse is the same as that of the quality of the convertend. In other words, if the convertend is affirmative then the converse is affirmative and if the convertend is negative then the converse is also negative.

iii. The quantity of the converse will be determined according to the principle of distribution, i.e. no term is distributed in the converse if it is not distributed in the convertend.

From the definition and the rules of Conversion as stated above, it follows that given a convertend, the converse of it is obtained just by interchanging the subject and predicate of the convertend so that the quality of the converse should be same as that of the convertred. Moreover, the principle of distribution should not be violated. Thus, to find the converse of any given convertend, we have to find answers to these following questions, viz. what should be the subject of the converse? What should be the predicate of the converse? What should be the quality of the converse? And what should be the quantity of the converse? Since we have four types of propositions, A, E, I and O, let us check to findout the converse (if any) of these four types of propositions.

Conversion of A-Proposition :

Let an A-proposition 'All S is P' be our convertend. To find its converse, let us interchange the subject and the predicate of the convertend according to the first condition of the definition of Conversion. Hence, 'S' being the subject of the convertend becomes the predicate of the converse and 'P' being the predicate of the convertend becomes the subject of the converse. Then according to the second condition, the quality of the converse must be affirmative because the convertend is affirmative. So the negative propositions E and O are ruled out as the converse of A proposition by this condition. So far as the quantity of the convserse is concerned we have the options, that the converse is either an A-proposition or an I proposition.The first option is also ruled out, because, if the converse of an A-proposition would be an A-proposition then P being the subject of the converse will be distributed in the converse without being distributed in the convertend. This will violate the rule of distribution. So only I-proposition can be the converse of an A-proposition. So, we conclude that the conversion of an A-proposition is an I-proposition. For example,

A	All S is P.	Convertend
I	Some P is S.	Converse
A	All men are mortal.	Convertend
I	Some mortal beings are men.	Converse

Note that in some special cases the conversion of an A-proposition is also an A-propositions. Consider any A-proposition asserting a definition (e.g. "All traingles are plane figures bounded by three straight lines") or an A-proposition where the subject and predicate are co-referential (e.g. "All creatures with a heart are creatures with kidneys) as our convertend. To get the converse, the subject and the predicate of the convertend are being transposed i.e. the subject of the convertend becomes the predicate of the converse and the predicate of the convertend becomes the subject of the converse. The quality of the converse is the same as that of the convertend. Thus, the converse of an A-proposition is either A-proposition or an I-proposition. For example, if we derive an I-proposition such as "Some plane figures bounded by three straight lines are traingles" from an A-proposition, "All traingles are plane figures bounded by three straight lines," then the converse seems to be odd as it gives the impression in our ordinary use of language that there can be plane figures bounded by three straight lines which are not triangles. Hence in such case (or cases) the converse of an A-proposition is an A-proposition. For example,

A "All triangles are plane figures bounded by three straight lines." Convertend.

A "All plane figures bounded by three straight lines are triangles." Converse.

A "All creatures with a heart are creatures with kidneys." Convertend

A "All creatures with kidneys are creatures with a heart." Converse.

To sum up we may say in general that the converse of an A-proposition is an I-proposition but in some cases (where the subject and predicate terms of the convertend are co-referential or the convertend asserts a definition) the conversion of an A-proposition is an A-proposition.

Conversion of E-Proposition :

Let an E-proposition say "No S is P" be our convertend. To find its converse, let us interchange the subject and predicate of the convertend. So, 'P' and 'S' will be subject and predicate of the converse respectively. By the second condition the converse will be negative as the convertend is negative. So far as quantity of the converse is concerned, it should be universal (i.e. an E-proposition) because in this case the principle of distribution is not violated. Because,

in the converse both the subject and predicate terms are distributed and these are also distributed in the convertend. Hence there is no violation of the principle of distribution. Thus, the converse of an E-proposition is an E-proposition.

E	No S is P	Convertend
E	∴ No P is S	Converse
E	No married person is a bachelor.	Convertend
E	∴ No bachelor is a married person.	Converse

Conversion of I-Proposition :

Let an I-proposition "Some S is P" be our convertend. To find its converse let us interchange the subject and predicate of the convertend. Thus, 'P' and 'S' will be the subject and predicate of the converse respectively by the condition (i) of the definition of conversion. The converse must be affirmative as the convertend is affirmative by condition (ii) of the definition of conversion. But so far as the quantity of the converse is concerned, we have two options; Case-1 - the converse is an A-proposition and Case 2 - the coverse is an I-proposition. If case-1 holds (i.e. if the converse is an A-proposition) then P being the subject of the converse will be distributed without being distributed in the convertend. Hence the principle of distribution will be violated. So, Case-1 cannot hold. In other words, the converse of an I-proposition cannot be an A-proposition. If case 2 holds, then the converse of an I-proposition is an I-proposition. In this case, the principle of distribution is not violated, because converse being an I-proposition distributes no term. So the question of violation of the principle of distribution does not arise. Therefore, converse of an I-proposition is an I-proposition, For example,

I	Some S is P.	Convertend
I	∴ Some P is S.	Convserse
I	Some men are rich.	Convertend
I	∴ Some rich persons are man.	Converse

Conversion of O-Proposition :

Let an O-proposition "Some S is not P" be our convertend. Then to find its converse we have to interchange the subject and predicate in the convertend. Hence, 'P' and 'S' would be our subject and predicate of the converse respectively. Further, the converse would be negative as the convertend is negative according to the condition (ii) of the definition of conversion. So far as its quantity is concerned we have two cases for consideration viz. Case I converse is an E-proposition and Case-2, converse is an O-proposition. In either case, S being the predicate term of the converse will be distributed in the converse without being distributed in the convertend. Thus, in both the cases the principle of distribution would be violated. Therefore, O-proposition admits (or has) no converse. In other words, an O-proposition cannot be converted.

Now we may say that the converse of A, E and I-proposition is I, E and I-proposition respectively. Hence, two forms of conversion are being recoginsed. These are (i) Simple conversion and (ii) Conversion per limitation (or Conversion per Accidens). Conversion is called simple if both the convertend and the converse have the same quantity. For example, E and I propositions admit simple conversion. The conversion of an E-proposition is an E-proposition and so also the conversion of an I-proposition is an I-proposition. Sometimes, the conversion of an A-proposition admits simple conversion if the subject and predicate terms of the convertend have the same denotation, i.e. they are co-referential. For example,

A	All triangles are plane figures bounded by three straight lines.	convertend.
A	∴ All plane figures bounded by three straight lines are triangles.	converse.

In this example, the subject and predicate terms of the convertend have the same denotation or they are co-referenial. So, the conversion of A-proposition in these cases would be again an A-proposition. In other words, if the denotation of the subject and predicate terms of the convertend are equal (or co-referential) then the conversion of an A-proposition is also an A-proposition. But, in general the conversion of an A-proposition is an I-proposition. We may summarise the immediate inferences relating to conversion in a tabular form as given below.

Converted		Converse	
A	All S is P.	Some P is S.	I
E	No S is P.	No P is S.	E
I	Some S is P.	Some P is S.	I
O	Some S is not P.	Not Possible	Nil

(Table of Conversion)

1.3 Obversion :

Obversion is another type of immediate inference. The premise and the conclusion of obversion are known as obvertend and obverse respectively. In obversion we get an affirmative equivalent of a negative proposition or a negative equivalent of an affirmative proposition by taking the contradictory of the predicate as predicate and changing the quality. Obversion may be defined as a kind of immediate deductive inference satisfying following conditions :

(i) The subject of the obverse is same as that of the subject of the obventend. In other words, if the term 'S' is the subject of the obvertend then the same 'S' is the subject of the obverse.

(ii) The predicate of the obverse is the contradictory of the predicate of the obvertend. In other words, if P is the predicate of the obvertend, then the contradictory of P i.e. 'not –P' is the predicate of the obverse.

(iii) The quality of the obverse is the opposite of the quality of the obvertend. This means, if the obvertend is affirmative then the obverse is negative and if the obvertend is negative, the obverse is affirmative.

(iv) The quantity of the obverse is same as that of the quantity of the obvertend. In other words, if the obvertend is universal then obverse is universal and similarly, if the obvertend is particular, the obverse is particular.

Note that these conditions effectively give us a method of obtaining or finding an observe for any categorical proposition that is in standard form. The acceptability of the process of obversion involves the following argument. As we know that when a predicate term P is affirmed (or denied) of the subject, its contradictory i.e. 'not P' is denied (or affirmed) of subject. This is so because any term 't' and its contradictory 'not-t' are mutually exclusive. Since the predicate of the obverse is the contradictory of the predicate of the obvertend, the moment we change the quality the obverse and the obvertend become equivalent. Because, here a kind of double negative rule (i.e. "a double negation is equivalent to affirmation") is involved. Now let us see the application of the process of obversion as it pertains to different types of logical propositions such as A, E, I and O-propositions.

Obversion of A-Proposition :

Let an A proposition of the form 'All S is P' be our obvertend. To obtain its obverse, let us follow the following instructions. The subject of the obverse would be S, according to condition (i) Then "Not - P" being the contradictory of the predicate of the obvertend, would be the predicate of the obverse by use of the condition (ii) of the definition of obversion. According to the condition (iii) the quality of the obverse is negative as the onvertend is affirmative. Further, according to the condition (iv) the quantity of the obverse would be same as that of the quantity of the obvertend. Thus, taking these conditions into consideration the obverse of an A-proposition of the form "All S is P' is an E-proposition of the form "No S is not- P". For example,

A	All S is P.	Obvertend
E	∴ No S is not –P.	Obverse

Similarly

A	All men are mortal.	Obvertend
E	∴ No men is non-mortal.	Obverse

Obversion of E-Proposition :

Let the obvertend be an E-proposition of the form "No S is P". To find the obverse of an E-proposition we follow the following instructions. By our condition (i) as given above 'S' would be the subject of the obverse because 'S' is the subject of the obvertend. According to condition (ii) 'Not-P', being the contradictory of the predicate 'P' of the obvertend would be the predicate of the obverse. Further, according to the condition (iii) quality of the obverse would be affirmative as the obvertend is negative. Finally, according to the condition (iv), the quantity of the obverse would be the same as that of the quantity of obvertend. Thus, all these considerations imply that the obversion of an E-proposition is an A-proposition. For example,

E	No S is P.	Obvertend
A	∴ All S is non- P.	Obverse

Similarly,

E	No man is perfect.	Obvertend
A	∴ All men are non-perfect.	Obverse.

Obversion of I-Proposition :

Let the obvertend be an I-proposition of the form "Some S is P". Then to obtain its obverse, we follow the following instructions. Firstly, by the condition (i) 'S' would be the subject of the obverse. Then 'P' being the predicate of the obverted, "not-P" would be the predicate of the observe by the condition (ii) of obversion. Further, by condition (iii) the observe would be a negative proposition as the obvertend is an affirmative proposition (i.e I-proposition). Finally, according to condition (iv) the observe would be particular as the obvertend is particular. Therefore, taking all these into account, we conclude that the obverse of an I-proposition, "Some S is P", would be an O-proposition of the form "Some S is not not-p", For example.

I	Some S is P.	Obvertend
O	∴ Some S is not non-P.	Obverse.

Similarly,

I	Some men are poor.	Obvertend
O	∴ Some men are not non-poor.	Obverse

Obversion of an O-proposition :

"Some S is not P" is an O-proposition for which we now try to obtain its obverse. As explained earlier according to the condition (i) and (ii) of the definition of obversion, the subject and the predicate of the obverse would be "S" and "not-P" respectively. By the condition (iii), the obverse would be affirmative as the obvertend is negative. Finally, according to the condition. (iv) the obverse would be particular as the obvertend is particular. From all these considerations, we conclude that the obverse of an O-proposition is an I-proposition. For example,

O	Some S is not P.	Obvertend
I	∴ Some S is not-P.	Obverse.

Similarly,

O	Some men are not wise.	Obvertend.
I	∴ Some men are not-wise.	Obverse.

We may now summarise the immediate inferences relating to obversion in a tabular form as given below.

Obvertend		Obverse	
A	All S is P.	E	No S is not-P.
E	No S is P.	A	All S is not-P.
I	Some S is P	O	Some S is not not-P
O	Some S is not P.	I	Some S is not-P.

(Table of Obversion)

1.4 Contraposition :

The third variety of immediate inference is contraposition. Its main objective is to form an equivalent proposition for a given proposition by transposing the subject and the predicate terms by their complements. But, unlike conversion and obversion, it is not an independent form of immediate inference. It may be defined as a series of immediate inferences consisting of Obversion and Conversion applied in a particular order to a given premise. In other words, to form the contrapostive of a given proposition, we first obvert it, then convert the result and obvert the result again. The conclusion of contraposition is called contrapositive, while its premise has no corresponding name. Hence,we shall follow the general convention and call the proposition to which we apply contraposition as the premise.

The contrapositive of a given proposition may be obtained by replacing the subject term by the contradictory of the predicate term and the predicate term by the contradictory of the subject term in the given premise. Accordingly, the contrapositive of an A-proposition, "All members are voters" is "All non-voters are non-members". Symbolically we may restate it as follows.

A	All S is P.	Premise
A	∴ All non-P is non-S.	Contrapositive

Similarly,

A	All members are voters.	Premise
A	∴ All non-voters are non-members.	Contrapositive

In the above example, the subject term 'members' is replaced by the contradictory of the predicate term "non-voter". Similarly the predicate term of the premise 'voters' is replaced by the contradictory of the subject term "non-members". Thus, we get. "All non-voters are non-members" as the contrapositive of "All members are voters." Similarly the contrapesitive of "All S is P" is "All not -P is non -S". We can follow the following procedure to obtain the contrapositive of a given proposition. First obvert the premise, then convert the result and obvert it again.

Contraposition of A-Proposition :

Let us find out the contraposition of an A-proposition "All S is P". To find the contrapositive, we first apply obversion to the premise, then apply conversion to the result and obvert it again to obtain the contrapositive of the premise.

(1)	All S is P	Premise.
(2)	No S is non-P	1, Obversion.
(3)	No non-P is S	2, Conversion.
(4)	All non-P is non-S	3, Obversion.

Here our premise is an A-proposition for which we wish to obtain the contrapositive. So we apply obversion to 1 which yields 2. We write the justification for (2) on the right-hand side of step 2 as shown above . This means we obtain (2) from (1) by use of obversion. Further, we apply conversion to (2) to get (3). Finally, we write the justification for (3) on its right-hand side as "2, conversion". This means (3) is obtained from (2) by use of conversion. Finally the application of obversion to (3) yields (4) that is the contrapositive of (1). Thus, the contrapositive of an A-proposition is an A-proposition.

Contraposition of E - Proposition :

Here our premise is an E-proposition for which we wish to find the contrapositive. Hence, we write our premise "No S is P" as step 1 and on its right hand side we write 'premise' as the justification for (1). Then we obtain step 2 by applying obverse to step 1. Similarly step 3 is obtained from step 2 by use of conversion. Finally, at step 4 we get the contrapositive "some non-P is not non-S" of "No S is P" by the application of obversion to step 3. Thus, the contrapositive of an E-proposition is an O-proposition. We rewrite above reasoning in a logically systematic manner as given below

(1)	No S is P	Premise
(2)	All S is non-P	1, Obversion.
(3)	Some non-P is S	2, Conversion.
(4)	Some non-P is not non-S	3, Obversion.

Contraposition of I - Proposition :

Let "Some S is P" be our premise for contraposition. We write it in step 1. Then, step 2 is obtained from step 1 by use of obversion. Thus, step 2 we get "Some S is not non-P", that is an O-proposition. Since an O-proposition cannot be converted, I-proposition cannot have any contrapositive. Thus, we conclude that an I-proposition has no contrapositive.

Contraposition of O - Proposition :

(1)	Some S is not P	Premise.
(2)	Some S is non-P	From1, by Obversion.
(3)	Some non-P is S	Form 2, by Conversion.
(5)	Some non-P is not non-S	From 3, by Obversion

Let our premise be O-proposition say 'Some S is not P'. We apply Obversion to step 1 to obtain step 2 which is an I-proposition. Then, by the application of conversion to step 2 we obtain step 3 (Some non-P is S). Finally we apply obversion to step 3 to get our desired contrapositive, namely "Some non-P is not non-S." Thus the contrapositive of an O-proposition is an O-proposition.

	Premise	Contrapositive	
A	All S is P	A	All non-P is non-S.
E	No S is P	O	Some non-P is not non-S.
I	Some S is P	I	proposition has no contrapositive.
O	Some S is not P	O	Some non-P is not non-S.

(Table for Contraposition)

SUMMARY

Immediate Inference

Deductive inferences are of two types, viz. immediate and mediate. In immediate inference the conclusion is drawn directly form a single premise and in mediate inference the conclusion is drawn from more than one premise. There are mainly three types of immediate inference. These are conversion, obversion, and contraposition.

In conversion a conclusion is drawn from a categorical proposition by interchanging the subject and the predicate. Quality remains the same. Quantity however may change. A term not distributed in the premise is not distributed in the conclusion.

Conversion is perfectly valid in case of E and I propositions. Simple conversion of A is not valid. But conversion by limitation is possible for A proposition. Conversion of an O proposition is not valid.

Convertend	Converse
A - All S is P.	I - Some P is S.
E - No S is P.	E - No P is S.
I - Some S is P.	I -Some P is S.
O - Some S is not P.	Cannot be converted

In Obversion the quality of the proposition is changed and the predicate term is replaced with its complement. Quantity remains the same. A term not distributed in the premise is not distributed in the conclusion.

Obvertend	Obverse.
A - All S is P.	E - No S is not-P.
E - No S is P.	A - All S is not-P.
I - Some S is P.	O - Some S is not not-P.
O - Some S is not P.	I - Some S is not-P.

Contraposition is an immediate inference in which the contrapositive is obtained by replacing its subject term with the complement of its predicate term and (b) replacing the predicate term with the complement of its subject term.

Form	Propositon	Contrapositive	
A	All S is P.	A	No non- P is non-S.
E	No S is P.	O	Some non-P is non-S.
I	Some S is not P.		No valid contrapositive is possible.
O	Some S is not P.	O	Some non-P is not non-S.

Contraposition is valid for A, E and O statements, invalid for I propositions.

MODEL QUESTIONS

Objective-type questions :

I. Fill in the blanks by using the appropriate word (s) given within the brackets in each case.

1. When a conclusion is drawn from one premise, the inference is said to be _____. (mediate, immediate, incomplete, complete)
2. In _____ the subject and the predicate terms of the proposition are interchanged. (conversion, contraposition, obversion, contradiction)
3. The proposition "No cricketers are film stars" may be obtained from the proposition "No film stars are cricketers" by _____. (conversion, contraposition, obversion, contradiction)
4. In conversion by limitation there is change in _____ of the proposition. (quality, quantity, both quality and quantity, neither quality nor quantity)
5. To obvert a proposition, we change its _____ and replace the _____ term by its complement. (quality, quantity, subject, predicate)
6. The premise of inference by obversion is called the _____ and the conclusion is called the _____. (obverter, obvertend, obverse, obvertee)

7. The premise of inference by conversion is called the _____ and the conclusion is called the _____. (converter, convertend, converse, convertee)
8. Conversion of _____ proposition is not valid. (A, E, I, O)
9. From 'Some S is P' one can validly infer 'Some S is not non-P' by _____. (conversion, obversion, contraposition, simple conversion)
10. The converse of E proposition is _____. (A, E, I, O)

II. Give, where possible, the converse of the following propositions:

1. All women are affectionate persons.
2. No Indians are Pakisthanis
3. Some students are honest.
4. Some Odias are not teachers.

III. Give the obverse of the following propositions:

1. All lawyers are honest.
2. No student is a teacher.
3. Some policemen are strong.
4. Some men are not emotional.
5. All demons are devils.
6. No foreigners are voters.
7. Some mammals are leopards.
8. Some rectangles are not squares.

IV. Point out which of the following immediate inferences are valid and which are invalid.

(1) All wise men are modest.

∴ No wise men are non-modest.

(2) Some students are not industrious.

∴ Some industrious persons are not students.

(3) None but the brave deserve the fair.

∴ All brave men deserve the fair.

(4) All discontented persons are unhappy.

∴ All unhappy persons are discontented.

(5) All dogs are quadrupeds.

∴ No non-quadrupeds are non-dogs.

(6) No communists are capitalists.

∴ No capitalists are communists.

(7) All logicians are philosophers.

∴ All non-philoshophers are non-logicians.

(8) Some teachers are not rich persons.

∴ Some non-rich persons are not non-teacher.

(9) Some communists are atheists.

∴ Some non-atheists are non-communists.

(10) No students are teachers.

∴ No non-teachers are non-students.

Essay-type Questions :

1. Distinguish between immediate and mediate inference. Is immediate inference an inference at all ? Discuss.
2. State and explain the rules of conversion. Explain why O proposition cannot be converted.
3. State and explain the rules of obversion.
4. State and explain the rules of contraposition.
5. Distinguish between
    a) Mediate and immediate inference
    b) Simple conversion and conversion by limitation.

***

CHAPTER- 2

CATEGORICAL SYLLOGISM

2.1 The Nature of Syllogism :

Syllogism is a form of mediate inference. In an immediate inference, we draw a conclusion from a single premise. But in case of a mediate inference, we draw a conclusion from the joint assertion of more than one premise. Syllogism is a form of argument in which we draw a conclusion form the joint assertion of two premises. For example,

All teen-agers are fond of cartoon pictures.

Some school-going students are teen-agers.

Therefore, some school-going students are fond of cartoon pictures.

In the above argument, the conclusion follows from both the premises taken together. The conclusion is justified by the assertion of both the premises. In other words, the premises jointly support the conclusion and the conclusion is supported by both the premises.

Syllogisms have different forms. Syllogisms may be classified as pure and mixed. Pure-syllogisms are classified as categorical and Hypothetical. Mixed-syllogisms are classified as Hypothetical, Alternative, Disjunctive and Dilemma. In this chapter we will deal with pure categorical syllogisms. Hereafter in this chapter we will often use 'syllogism' to mean pure categorical syllogism. When we will talk of other forms of syllogism we will qualify them accordingly.

DEFINITION: A categorical syllogism is a deductive argument consisting of three categorical propositions that together contain exactly three terms, each of which occurs exactly twice in the argument. We may elaborate the definition as follows.

1. A syllogism must have three propositions (out of which two supporting propositions are the *premises* and the one drawn from the premises is the *conclusion*.)
2. A syllogism should have *three terms.*
3. The premises and the conclusion are categorical propositions (like A,E,I and O).
4. The conclusion necessarily follows from the premises. The relation between the premises and the conclusion is one of logical implication.

2.2 Structure of Syllogism :

Every syllogism has *three and only three terms*. These terms are *major term, minor term* and *middle term*. Each term occurs twice in the syllogism. In order to identify a term in a syllogism, we have to take in to account the conclusion of the given argument. Let us consider the following classical syllogistic argument.

All men are mortal.
Socrates is a man.

Therefore, Socrates is moral.

In the above argument, " Socrates is mortal" is the conclusion, "All men are mortal" and "Socrates is a man" are the premises. The subject term of the conclusion is called *the minor term* (symbolically called *S*). The predicate term of the conclusion is called the *major Term* (symbolically called *P*). The term which is common in both the premises but does not occur in the conclusion is called the *middle term* (symbolically called *M*). In the above argument, "Socrates" stands for the minor term, "mortal" stands for the major term and "man" for the middle term. The middle term, which occurs in both the premises, acts like a bond or connection between the two premises. It is the common element in both the premises. The major term and the minor term are called *Extremes*. The middle term is connected with both the extremes so that a conclusion can be drawn. The premise in which the minor term occurs is called the *minor premise*. The premise in which major term occurs is called the *major premise*. The *conclusion* is obtained by the joint assertion of both the major premise and the minor premise. In a syllogism generally *the major premise is stated first, the minor premise second* and *the conclusion last*. Let us take another example.

All ruminants are horned animals.
All cows are ruminants.

Therefore, all cows are horned animals..

Here 'Cows' stand for the minor term, 'horned-animals' for the major term and 'ruminants' for the middle term. If we symbolize them as per the symbols taken earlier, the above argument can be represented in the following manner.

All M is P.
All S is M.

Therefore, all S is P.

This is the *form of the argument*. The from of the syllogism is the symbolic representation of the argument. The validity or invalidity of an argument depends exclusively on its form. It is independent of the subject matter or *content* of the argument. We may substitute any value for S, P and M in the form but the argument remains valid. Suppose we substitute "rabbit" in place of 'S', "having lungs" for 'P' and "mammals" for 'M', we may get a new argument after substitution in the following manner.

All mammals have lungs.
All rabbits are mammals.

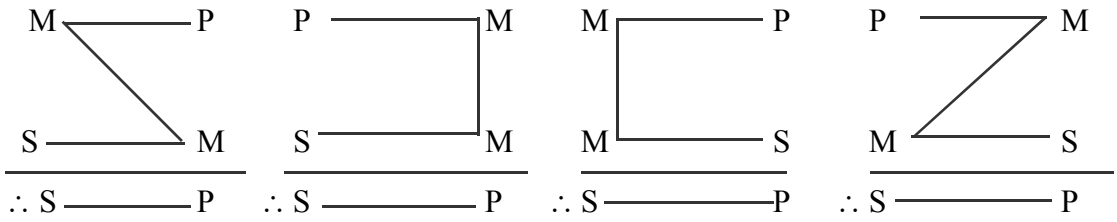
Therefore, all rabbits have lungs.

This argument is also valid. So, we can conclude that a valid syllogism is a formally valid argument i.e. it is valid due to its form alone. Similarly, if a syllogism is invalid, its form is also invalid. The validity or invalidity of an argument is dependent on its form, not on the content of the syllogism.

2.3 Figure of Syllogism :

Figure of a syllogism is determined by the position of the middle term in the premises. There are four different possibilities. The middle term may occur as (1) subject in the major premise and predicate in the minor premise (2) predicate of both the premises (3) subject in both the premises or (4) predicate in the major premise and subject in the minor premise.

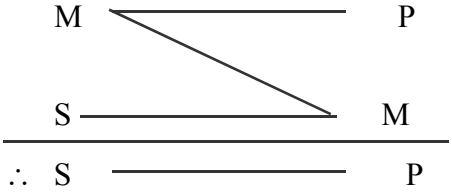
The figures of a syllogism may be represented in the following manner.



(Fig. I) (Fig. II) (Fig.III) (Fig. IV)

The different possible positions of the middle term in a syllogistic argument constitute the above first, second, third and the fourth figures of syllogism.

Fig.-I



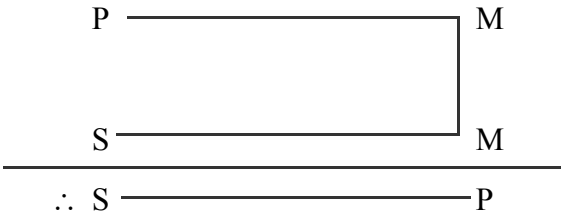
The first figure looks like a reverse Z shape. In the first figure, the middle term is the subject of major premise and the predicate of the minor premise.

The following are examples of arguments belonging to the first figure.

(i) All M is P.
All S is M.
∴ All S is P.

(ii) All men are mortal.
All politicians are men.
∴ All Politicians are mortal.

Fig-II



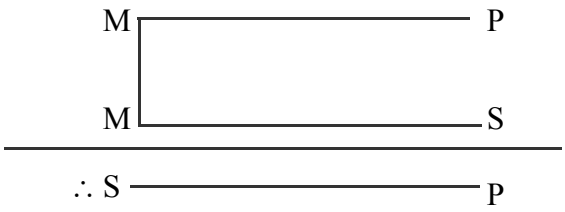
The second figure of the Syllogism takes the shape of a horse-shoe magnet. Here, the middle term is the predicate term in both the premises. The example of an argument belonging to Fig.-II is as follows.

(i) No P is M.
All S is M.
∴ No S is P.

(ii) No crows are quadruped.
All cows are quadruped.
∴ No cows are crows.

Fig.-III

The shape of third figure is the reverse of that of the second figure. In third figure, the middle term is the subject of both the premises.



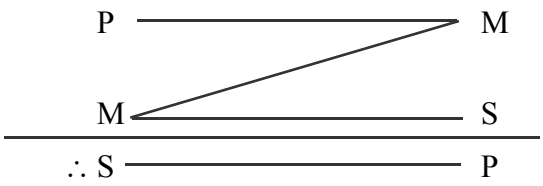
The examples are as follows.

(i) All M is P.
All M is S.
∴ Some S is P.

(ii) All men are thinkers.
All men are vertebrates.
∴ Some vertebrates are thinkers.

Fig. - IV

The fourth figure looks like a Z. In the fourth figure the middle term is predicate in the major premise and subject in the minor premise. The figure is represented in the following diagram.



The following are examples of arguments in the fourth figure.

(i) All P is M.
No M is S.
∴ No S is P.

(ii) All Parrots are biped animals.
No biped animal is a dog.
∴ No dog is a parrot.

We can sum up the discussion by noting that the figure of a syllogism depicts the position of the middle term in an argument and we can know whether an argument belongs to figure I, II, III or IV from the position of the middle term. We can summarize the position of the middle term in different figures in the following manner.

1. In figure-I, the middle term is the subject of the major premise and the predicate of the minor premise.
2. In figure-II, the middle term is the predicate in both the premises.
3. In figure-III, the middle term is the subject of both the premises.
4. In figure-IV, the middle term is the predicate in the major premise and subject of the minor premise.

2.4 Moods of Syllogism :

In the previous section we have introduced the notion of the figure of syllogism. This notion considered alone is not adequate to determine the form of syllogistic arguments. Because both valid and invalid syllogistic forms may belong to the same figure. For example

(1) All men are mortal.
All kings are men.
Therefore, all kings are mortal.

and (2) Some men are rich.
Some beggars are men.
Therefore, some beggars are rich.

Clearly, these two arguments belong to the first figure. Out of these two, the former is valid and the latter is invalid. Hence, just knowing the figure of a syllogism is not enough to know its form. Unless we know the form of a syllogism, we cannot decide its validity or invalidity. Therefore, in addition to the notion of figure, we also need the notion of "mood" of syllogism. These two notions taken together determine the form of a syllogism. In what follows we explain the notion of mood of a syllogism.

As we already know, a syllogism is called categorical if all its premises as well as the conclusion are all categorical propositions. Further, a categorical syllogism is put in its standard form if its major premise is stated first, the minor premise is stated after the major premise and finally the conclusion is stated.

The word "mood" in syllogistic logic is used in three different senses. Firstly, the mood of a syllogism is determined by the quality and quantity of the constituent premises. Since the quality and quantity of any premise is reflected by its logical form, the mood of a given syllogism is obtained by writing the logical form of each of the constituent premises. Accordingly; the mood of the argument (1) given above is "AA". This is so because the major and minor premises of the argument (1) are A-propositions. Similarly the mood of argument (2) given above is 'II'.

As we know that a syllogism contains two premises and each of the premises can admit any one of the four possible forms (viz. A, E, I or O), so the total number of possible configurations on moods would be $4^2 = 4 \times 4 = 16$. This may be exhibited in tabular form as shown below.

A A	E A	I A	O A
A E	E E	I E	O E
A I	E I	I I	O I
A O	E O	I O	O O

The mood in this sense is also well-know as mood in the wide sense.

Since there are four figures, the total number of moods would be 64. We shall soon see that out of these sixty four moods only nineteen moods are valid. These are as follows

Figure	Valid moods
First Figure	A A, E A, A I and E I
Second Figure	E A, A E, E I and A O
Third Figure	A A, I A, A I, E A, O A, and E I
Fourth Figure	A A, A E, I A, E A and E I

We may note that out of these nineteen valid moods, the mood "E A" and "E I" are valid in all figures.

Definition of Mood (in the second sense)

The mood of a syllogism is determined by the quality and quantity of the constituent propositions. In other words, the mood of a syllogism is obtained by specifying the logical forms of each of the constitutent propositions. Unlike the first sense, here we have to consider the logical form of conclusion in addition to the logical forms of the premises. For example, in this sense the mood of the syllogism of argument (1) given above is "AAA". Similarly, the mood of argument (2) is "I I I". Here the first, second and third vowel respectively represents the logical form of major premise, minor premise and the conclusion. Since a syllogism consists of three

propositions and each of these propositions admits any one of the four possible logical forms, the total number of possible moods would be $4^3 = 4 \times 4 \times 4 = 64$. This may be shown as given below.

A A A	E A A	I A A	O A A
A A E	E A E	I A E	O A E
A A I	E A I	I A I	O A I
A A O	E A O	I A O	O A O
A E A	E E A	I E A	O E A
A E E	E E E	I E E	O E E
A E I	E E I	I E I	O E I
A E O	E E O	I E O	O E O
A I A	E I A	I I A	O I A
A I E	E I E	I I E	O I E
A I I	E I I	I I I	O I I
A I O	E I O	I I O	O I O
A O A	E O A	I O A	O O A
A O E	E O E	I O E	O O E
A O I	E O I	I O I	O O I
A O O	E O O	I O O	O O O

Since there are four figures, the total number of moods in all would be 64 x 4 = 256. The mood in this sense is called mood in the wider sense. In this sense, there will be twenty four valid moods i.e. six in each figure. These are as follows :

Figure	Valid moods
First figure	A A A, A A I, E A E, E A O, A I I, E I O
Second figure	E A E, E A O, A E E, AE O, E I O, A O O
Third figure	A A I, I A I, A I I, E A O, O A O, E I O
Fourth figure	A A I, A E E, A E O, I A I, E A O, E I O

It may be noted that the moods "E A O" and "E I O" are valid in every figure.

Definition of mood (in the third sense)

The word "mood" is used in the sense of valid moods of syllogism. For example, the syllogistic argument (2) as given in this section has the configuration "I I" (understanding mood in the wide sense) or I I I (understanding mood in the wider sense). Since neither of them are valid, they are not moods in the third sense. This sense of mood is mood in the narrow sense.

We note that the division of three senses of mood (viz wider, wide and narrow) is dependent on the admission of the total number of moods in all the four figures. Since the total number of moods in the second sense is the highest (i.e. 256) it is called mood in the wider sense. Similarly, the total number of moods in the first sense is sixty four. So it is called mood in the wide sense. Finally the mood in the third sense is called mood in the narrow sense as the total number of moods in all figures is the lowest.

Representation of form of syllogism

The form of categorical syllogism is determined by its figure and mood. For example, consider the following syllogistic argument.

All M is P.
Some S is M.
Therefore, some S is P.

Clearly this syllogism belongs to first figure and its mood is "A I I". Thus the form of the above syllogism is described by the expression "A I I – 1". Where the first and second vowel denote the major and minor premise and the third vowel denotes the conclusion. Further, "1" denotes first figure. Similarly in case of "A I I – 2", "2" denotes second figure and so on. In what follows we discuss testing of moods in the first sense.

2.5 Rules of Syllogism

A valid categorical syllogism must conform to certain rules. These rules of syllogism are the norms or standard that help us to test the validity or the invalidity of the moods. If we draw the conclusion in accordance with the rules of syllogism, the argument is valid or else it becomes invalid. The violation of any of the rules leads to a logical mistake otherwise called a logical fallacy. Let us discuss the rules of syllogism and the corresponding fallacies that are committed when the rules are violated. Mainly, we will deal with the following topics while

discussing the rules of syllogism. These are

(A) General Syllogistic Rules.
(B) Special Syllogistic Rules.
(C) Aristotle's Dictum.

(A) General Syllogistic Rules :

General syllogistics rules are the fundamental and basic rules applicable to all syllogisms in general. These are ten in number. Out of these ten, some are based on the very definition of syllogism and some rules are derivative in nature. Let us discuss them in detail.

Rule - 1

Every syllogism must have three and only three terms neither more nor less. This rule can not be regarded as a rule in the strict sense of the term because the very definition of syllogism states that a syllogism must have three propositions and three terms. These terms include the minor term, major term and the middle term. The middle term keeps relationship with the extremes so that a conclusion is drawn. Similarly, we cannot avoid either the major term or the minor term. Thus, in a syllogism, it is necessary to have three and only terms.

If an argument has less than three terms (i.e. two terms), we cannot call it a syllogism, rather it is a case of immediate inference.

For example,

All *crocodiles* are *reptiles*

Therefore, some *reptiles* are *crocodiles*

Here there are two terms and it is a case of immediate inference.

If an argument contains more than three terms (i.e. *four terms*), it cannot be called a syllogism. We commit the *fallacy of four terms*. For example,

All cows are *quadruped animals*.

All dogs are *faithful animals*.

From this, we cannot draw any conclusion. It is a case of *fallacy of four terms*.

Sometimes a term is used in different senses in the same argument. In such a case, we commit the *Fallacy of Equivocation*. This fallay has three forms. When the major term is used

ambiguously, we call it the Fallacy of *ambiguous major*. For example,

Light is essential to guide our steps
Lead is not essential to guide our steps
Therefore, lead is not light.

The major term 'light' in the above argument has been used in one sense in the major premise, but in another sense in the conclusion.

Similarly, when the minor term is used ambiguously, we commit the *fallacy of ambiguous minor*. For example,

No man is made of paper.
All pages are men.
Therefore, no *pages* are made of paper.

In this argument, the minor term 'page' has been used in two different senses.

When the middle term is used ambiguously, we commit the fallacy of ambiguous middle. For example,

Sound travels at the rate of 1120 feet per second.
His knowledge of mathematics is sound
Therefore, his knowledge of mathematics travels at the rate of 1120 feet per second.

Rule-2:

Every syllogism must have three and only three propositions.

This is also not a rule in the strict sense of the term. Like Rule-I, it states a necessary condition that a syllogism must have three propositions out of which two are called premises and what follows from the premises is called the conclusion. If we take *less than three* propositions, the argument might become an *immediate inference* or if we take *more than three* propositions, we get a *train of syllogisms or Sorites*.

Rule-3:

In a valid syllogism, the middle term must be distributed at least once in any of the premises.

The role of middle term in a syllogism is important because it connects both the extremes. In order to establish a relation between the extremes (major and minor terms) in the conclusion, extremes should be shown to be connected in some common part of the middle term. In other

words, for establishing a connection between the major and minor term in the conclusion, at least one of them must be related to the whole of the middle term, otherwise each of them might be connected only to with a different part of the middle term. If the middle term is not distributed at least once in the premises, both the extremes are not shown to be connected and we commit the *fallacy of undistributed middle*. For example,

All dogs are *quadruped*.
All cats are *quadruped*.
So, all cats are dogs.

In both the premises, the middle term is undistributed (since A proposition doesn't distribute its predicate). No conclusion is possible as the middle term is not properly connected with the extremes. When this rules is violated we *commit* the *fallacy of undistributed middle*.

Rule-4

In a categorical syllogism, *if a term is distributed in the conclusion, it must be distributed in the premise.*

This rule states a necessary condition of deductive validity. The conclusion of a valid deductive argument cannot be more general than the premises; the conclusion cannot go beyond the premises. The conclusion can only make explicit what is implicitly present in the premises. Syllogistic arguments, being deductive, must abide by this condition.

The conclusion of a syllogism has two terms. These are minor term and major term. Neither the major term nor the minor term should be distributed in the conclusion if it is not distributed in the premise. Of course, the reverse is not a fallacy. A term which is distributed in the premise may remain undistributed in the conclusion.

If the minor term is distributed in the conclusion but not distributed in the minor premise, we commit the *fallacy of illicit minor*. For example,

All men are rational.
All men are biped.
$\therefore$ Therefore, all *bipeds are rational*.

Here the minor term 'biped' (subject term of conclusion) is distributed which is not distributed in the minor premise (being the predicate of A proposition). So the *fallacy committed in this argument is illicit minor*.

Similarly, if the major term is distributed in the conclusion without being distributed in the major premise, we commit the *fallacy* of *illicit major*. For example,

All cows are quadruped.
No goats are cows.
Therefore, no goats are quadruped.

Here, the major term is distributed in the conclusion but not in the major premise (since it is the predicate of an A proposition). So the *fallacy of illicit major is committed in this argument*.

Rule-5

In a categorical syllogism, *no conclusion can be obtained from two negative premises*.

A negative proposition is one in which the predicate is denied of the subject i.e. the predicate is negatively related with the subject. If both the premises are negative, the middle term will be negatively related to the extremes and no relation can be established between them. So a valid conclusion cannot be drawn. If we draw a conclusion from two negative premises, we commit the *fallacy of two negative premises* or *fallacy of exclusive premises*.

No artists are rich persons.
Some rich persons are not theists.
Therefore, some theists are not artists.

Since both the premises are negative, the conclusion(some theists are not artists) is not valid and we commit the *fallacy of two negative premises* or *fallacy of exclusive premises*.

Rule-6

In a categorical-syllogism, *if either premise is negative*, *the conclusion must be negative* and *Vice Versa,* that is if the conclusion is negative, one of the premises must be negative. According to Rule-5 stated above, we cannot draw any valid conclusion from two negative premises. So, if one premise is negative, the other premise must be affirmative. If one premise is affirmative and the other premise is negative, then a relation of inclusion will be asserted

between the middle term and one of the extremes in the affirmative premise and the relation of exclusion will be asserted between the middle term and the other extreme. Thus, if one extreme is included in the middle term and the other extreme is excluded from the middle term, then there can be the relation of exclusion between the extremes, and they cannot have affirmative relation in the conclusion. Therefore, the conclusion will be negative. For example,

No poets are scientists.
Some philosophers are poets.
Therefore, some philosophers are not scientists.

This conclusion (negative one) is a valid conclusion. But if we draw any affirmative conclusion (such as "Some philosophers are scientists") from the above premises, it would be a fallacious conclusion. Here, we would have committed the *fallacy of drawing an affirmative conclusion from two negative premises*. Similarly, we can prove that if the conclusion is negative, one of the premises must be negative

Rule- 7

In a categorical syllogism, if both the premises are affirmative, the conclusion must be affirmative.

In an affirmative proposition, the predicate is affirmed of the subject. In other words, in an affirmative premise a relation of inclusion is asserted. If both the premises are affirmative, it is clear that the middle term is affirmatively connected with both the extremes i.e. the minor term and the major term. Thus it is obvious that the minor term and the major term are affirmatively related in the conclusion and the conclusion must be an affirmative proposition.

Similarly, the converse also holds good. If the conclusion is affirmative, both the premises must be affirmative.

Rule-8

In a categorical syllogism, *if both the premises are particular*, *no conclusion follows*. As we know, there are two types of particular propositions. These are I and O propositions. If both the premises are particular, then the possible combinations will be I I, I O, O I and O O.

In I I combination, since no term is distributed in I proposition the middle term is not distributed. So this combination will not yield any conclusion (as per Rule 3) stated above. In O O combination, there will be no conclusion (as per Rule 5) as it leads to the fallacy of two negative premises. Let us examine the combination of I O and O I. In either of the cases, since one premise is negative, the conclusion will be negative. If the conclusion is negative, the predicate of the conclusion (major term) will be distributed in the conclusion which could not be distributed in the premise because there is only one term distributed in the premises and it is reserved for the middle term to avoid the fallacy of undistributed middle). So no conclusion follows from any of the combinations when both the premises are particular. In other words, in a categorical syllogism at least one of the premises must be universal.

Rule-9

In a categorical syllogism, *if one premise is particular*, *the conclusion will be particular*. If one premise is particular, the other premise will be universal because according to Rule 8, stated above, from two particular premises no conclusion follows. We have also seen that from two negative premises no conclusion can be drawn (See Rule 5 stated above). So we get the following possible combinations.

AI, IA, AO, OA, EI, IE,

Let us examine each pair.

AI and IA: In this combination, total number of terms distributed is one which is left for the middle term (to avoid the fallacy of undistributed middle). So the conclusion will be a proposition that does not distribute any term (to avoid the fallacy of either illicit major or illicit minor). So the conclusion will be an I proposition which is particular.

AO and OA: In this combination where one proposition is A and the other is O, the total number of terms distributed in the premises is two, out of which one must be reserved for the middle term to avoid the fallacy of undistributed middle and there is only one term left as distributed. Since one premise is negative, the conclusion is bound to be negative (as per Rule-6). Thus the conclusion will be a negative proposition and it will have only one term distributed. The conclusion, therefore, must be an O proposition which is particular.

EI and IE : In this combination, total number of terms distributed in the premises are two out of which one is reserved for the middle term. So there is only one term left as distributed in the premise. Since one premise is E which is negative, the conclusion will be negative where only one term can be distributed. So it must be an O proposition, which is particular.

Thus we notice that if one premise is particular, the conclusion will be particular.

Rule-10 :

In a categorical syllogism, *if the major premise is particular and the minor premise is negative then no conclusion follows*.

If the minor premise is negative, the conclusion becomes negative (Rule 6) and the major premise is bound to be affirmative (Rule 5). Thus the major premise is a particular affirmative ('I') proposition. Since the conclusion is negative its predicate (major term) will be distributed in the conclusion which is not distributed in the major premise. So the fallacy of illicit major will be committed. Therefore, in a syllogism when the major premise is particular and minor premise is negative, no conclusion can be drawn.

2.6 Determination of Valid Moods :

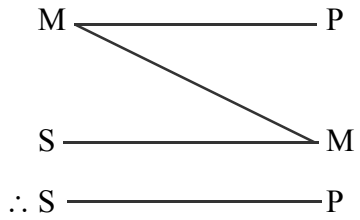
We have already discussed the general syllogistic rules. Let us apply these rules to the different ($16 \times 4 = 64$) possible moods. By application of the general syllogistic rules, we will see that there are only 19 valid moods. For the determination of valid mood, we must keep in mind the four figures discussed earlier and important general syllogistic rules. In each figure, these are the following sixteen combination of the premises.

A A	E A	I A	O A
A E	E E	I E	O E
A I	E I	I I	O I
A O	E O	I O	O O

Out of these sixteen possible combinations, by application of general syllogistic Rule 5 (i.e. No conclusion follows from two negative premises) we find E E, E O, O E and O O combinations can not yield any valid conclusion. Similarly, by applying general syllogistic Rule 8

(No conclusion follows from two particular propositions), combinations like I I, I O and IO can not yield any valid conclusion. By application of General syllogistic Rule 10, (From particular major and negative minor no conclusion follows) combination IE would not give any valid conclusion. Thus out of sixteen possible combinations only eight remaining combinations AA, A E. A I, A O, E A, E I, I A and O A are left. Let us examine these remaining combinations to find out which of these combinations can give rise to valid conclusion in which figure.

(a) Valid Moods of First Figure



The above diagram shows the position of terms in Fig-I, the middle term occupies the position of subject in the major premise and the predicate in the minor premise. Let us check the valid combinations in this figure .

1) AA

	All M is P	A
	All S is M	A
∴	All S is P	A

In AA combination, the middle term is distributed in the major premise. The minor term which is distributed in the conclusion is also distributed in the minor premise. Thus the conclusion is A and the argument is free from any kind of fallacy. Thus AAA combination is a valid mood in the first figure and it is named as BARBARA. The three vowels in BARBARA stand for the major premise, minor premise and the conclusion respectively.

2) AE

	All M is P	A
	No S is M	E
∴	No conclusion follows	

Since the minor premise is negative, the conclusion will be negative. In that case the negative conclusion will distribute its predicate which is the major term. But the major term is not

distributed in the major premise (as the predicate of A proposition). So if we draw any conclusion we shall commit the fallacy of illicit major. Thus in Figure-I, AE combination will not yield any valid conclusion.

3) AI

	All M is P	A
	Some S is M	I
∴	Some S is P	I

In AI combination, both the premises are affirmative, therefore the conclusion will be affirmative. Since one premise is particular, the conclusion will be particular. Thus the conclusion will be particular affirmative. The middle term is distributed in the major premise. In the conclusion, no term is distributed. So in AI combination, I can follow as the conclusion. Thus in Fig.1 we get AII as a valid mood and it is termed as DARII.

4. AO

	All M is P	A
	Some S is not M	O
∴	No conclusion follows	

In this combination since one of the premises is negative, the conclusion will be negative. Further, when one premise is particular the conclusion will be particular. Therefore, the conclusion will be particular negative or O proposition in which the predicate term (major term) will be distributed which is not distributed in the major premise. So there will be the fallacy of illicit major. Thus no valid conclusion can be drawn from AO combination in the first figure.

5. EA

	No M is P	E
	All S is M	A
∴	No S is P	E

In EA combination, since major premise is negative the conclusion will be negative. If we draw universal negative conclusion no rule will be violated. The middle term is distributed in the major premise. Both the minor and major terms are distributed in the conclusion and they are also distributed in the respective premises. So EAE is a valid mood in Figure-I. It is named as CELARENT.

6. E1

No M is P	E
Some S is M	I
∴ Some S is not P	O

Here one premise is negative, so the conclusion will be negative. Since one premise is particular, the conclusion will be particular. Hence the conclusion will be particular negative or O proposition in which the major term will be distributed. Since the major term is already distributed in the major premise no illicit process is involved. Thus EIO is a valid mood in first figure and it is named as FERIO.

7. IA

Some M is P	I
All S is M	A
∴ No conclusion follows	

In IA combination, the middle term is not distributed at least once in the premises. So we would commit the fallacy of undistributed middle if we derive any conclusion from IA combination in figure-I.

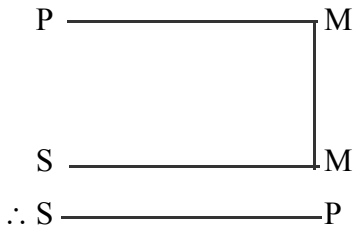
8. OA

Some M is not P	O
All S is M	A
∴ No conclusion follows	

In OA combination in first figure, the middle term is not distributed at least once in the premises; so no conclusion can follow from OA in the first figure.

Thus there are four valid moods in figure I. These are BARBARA, CELARENT, DARII and FERIO.

(b) Valid Moods of Second Figure



The above diagram shows the position of the terms in second figure. In this figure the middle term takes the position of predicate in both the premises. Let us test the eight possible combinations in the second figure for determination of its valid moods.

(I) **AA**

All P is M	A
All S is M	A
∴ No conclusion follows	

In the second figure the middle term takes the place of predicate in both the premises. When both the premises are A propositions middle term is undistributed being the predicate of affirmative proposition. So no valid conclusion can be drawn from AA combination in second figure.

2. AE

All P is M	A
No S is M	E
∴ No S is P	E

In AE combination the conclusion is bound to be negative as one premise is negative. The middle term is distributed once in the minor premise. There is no harm if we take E proposition as the conclusion. Both the terms will be distributed in the conclusion and they have been distributed in the respective premises. So the conclusion is a valid one and AEE is a valid mood in second figure. It is called CAMESTRES

3. AI

All P is M	A
Some S is M	I
∴ No conclusion follows.	

In AI combination in the second figure no valid conclusion can be drawn since the middle term is not distributed in either of the premises.

4. AO

All P is M	A
Some S is not M	O
∴ Some S in not P	O

As per general syllogistic rule, if one premise is negative, the conclusion will be negative. If one premise is particular, the conclusion will be particular. So the conclusion in second figure with AO combination will be an O proposition. The middle term has been distributed as the predicate of minor premise. The major term is distributed in the conclusion which is also distributed in the major premise as it occurs at the subject place in an A (universal) proposition. So AOO is a valid mood is in the second figure. It is technically called BAROCO.

5. EA

No P is M	E
All S is M	A
∴ No S is P	E

In second figure, EA combination can yield E as conclusion. It fulfills all the conditions of general syllogistic rules since the middle term is distributed in the major premise and both the terms distributed in the conclusion are also distributed in the respective premises. Hence EAE is a valid mood in second figure. It is technically called CESARE.

6. EI

No P is M	E
Some S is M	I
∴ Some S is not P	O

In second figure, EI combination will yield a conclusion which can be an O proposition. Since one premise is particular, the conclusion will be partiuclar and since one premise is negative, the conclusion will be negative. The middle term is distributed in the major premise. If the conclusion is O. then the major term (predicate of the conclusion) is distributed which is found to be distributed in the major premise (subject of E proposition). So EIO is a valid mood in this figure. It is technically called FESTINO.

7. IA

Some P is M	I
All S is M	A
∴ No conclusion follows	

IA Combination will yield no conclusion in second figure because the middle term is not distributed in either of the premises.

8. OA

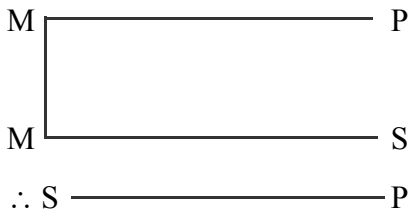
Some P is not M.	O
All S is M.	A

No conclusion follows.

In second figure OA combination cannot yield any conclusion. One of the premises (major) being particular negative, the conclusion must be so. The particular negative conclusion would distribute its predicate (major term) which is not distributed in the major premise. So we would commit the fallacy of illicit major. Thus no conclusion follows from OA combination in the second figure. Thus in fig-II, the valid moods are four in number. These are CAMESTRES, CESARE, BAROCO, FESTINO.

(c) Valid Moods of Third Figure

In the figure-III, the middle term occurs as subject in both the premises. The following diagram shows the position of the terms in third figure.



Let us test the possible combinations.

1. AA

All M is P.	A
All M is S.	A
∴ Some S is P.	I

Since middle term is subject of A proposition in both the premises, it is distributed in both the premises. But the major term and the minor term are not distributed in the premises as they are the predicate of affirmative propositions. So they cannot be distributed in the conclusion. So the conclusion can only be an I proposition which distributes no term. Thus AAI combination is a valid one in Figure-III. It is technically named DARAPTI.

2. AE

All M is P.	A
No M is S.	E

No conclusion follows.

The middle term is distributed in both the premises. Since one premise is negative, the conclusion, if any, is bound to be negative. If the conclusion is negative the major term will be distributed which is not distributed in the major premise. Thus the fallacy of *illicit major* will be committed So, no valid conclusion can be obtained from AE combination.

3. AI

All M is P	A
Some M is S	I
∴ Some S is P	I

In AI, the middle term is distributed in the major premise. Since one premise is particular the conclusion will be particular. Since both the premises are affirmative, the conclusion will be affirmative. Since the particular affirmative conclusion does not distribute any term, no illicit process of either the major or the minor term will occur. Thus AII is a valid mood in the third figure. It is technically named DATISI.

4. AO

All M is P	A
Some M is not S	O
No conclusion follows	

In AO combination, the middle term is distributed in the major premise (being the subject term of A proposition). When one premise is particular the conclusion will be particular. When one premise is negative, the conclusion will be negative. Thus the conclusion will be an O proposition in which the predicate is distributed which is not distributed in the major premise. So we would commit the fallacy of *illicit major*. Thus no valid conclusion can be drawn from AO combination in the third figure.

5. EA

No M is P	E
All M is S	A
∴ Some S is not P	O

In EA combination, the middle term is distributed in both the premises. The conclusion would be an 'O' proposition in stead of an E proposition(to avoid the fallacy of illicit minor). In the conclusion, major term is distributed which is distributed in the major premise. So EAO is a valid combination in Figure III. It is technically called FELAPTON.

6. EI	No M is P.	E
	Some M is S.	I
	∴ Some S is not P.	O

In this combination middle term is distributed in the major premise. The conclusion will be particular as one premise is particular. Further, the conclusion will be negative as one of the premises is negative. Thus the conclusion can be an O proposition which distributes the major term that has been distributed in the major premise. Therefore EI combination in Figure III yields EIO as a valid mood. It is technically named as FERISON.

7. IA	Some M is P.	I
	All M is S.	A
	∴ Some S is P.	I

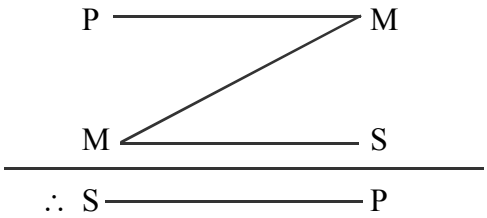
In IA combination, the middle term is distributed in the minor premise. Since one premise is particular, the conclusion is bound to be particular and the conclusion will be affirmative since both the premises are affirmative. Thus in IA combination, the conclusion can be particular affirmative (I) proposition. Thus IAI is a valid mood in third figure. It is technically named as DISAMIS

8. OA	Some M is not P.	O
	All M is S.	A
	∴ Some S is not P.	O

In OA combination, the middle term is distributed in the minor premise. The conclusion would be O proposition (since one premise is particular, the conclusion will be particular and since one premise is negative, the conclusion will be negative). In O conclusion, the major term is distributed which is also distributed in the major premise. Thus OAO is a valid mood in figure III. and it is named as BOCARDO

To Sum up, there are six valid moods in figure-III. These are DARAPTI, DATISI, DISAMIS, FELAPTON, FERISON, and BOCARDO.

(d) Valid Moods of Fourth Figure



In the fourth figure, the middle term occupies the position of predicate in the major premise and subject in the minor premise. Let us determine the valid moods by testing the possible combinations.

(1) AA

All P is M. A
All M is S. A

∴ Some S is P. I

In AA combination in this figure the middle term is distributed in the minor premise. Since both the primises are affirmative the conclusion will be affirmative. The conclusion cannot be an A proposition, as that would involve the fallacy of illicit minor. So the conclusion can only be an I proposition which does not distribute any term. Thus AAI is a valid mood in the fourth figure. It is named as BRAMANTIP.

(2) AE

All P is M. A
No M is S. E

∴ No S is P. E

In AE combination, the middle term is distributed in the minor premise.Since one premise is negative the conclusion will be negative. A negative conclusion distributes its predicat. Since it is also distributed in the major premise (as the subject of a universal proposition) no illicit process of that term is involved. The minor term also has been distributed in the minor premise. So no illicit process of the minor term will occur if we draw E proposition as conclusion.

Thus AEE is a valid mood in the fourth figure, which is technically called CAMENES.

(3) AI

All P is M. A
Some M is S. I

No conclusion follows.

In the fourth figure AI combination will not yield any conclusion as the middle term is not distributed at least once in the premise. It is not distributed in the major premise as it is the predicate of an affirmative proposition. It is also not distributed in the minor premise as it is the subject of a particular proposition. Thus no conclusion follows form AI continution in the fourth figure.

(4) AO	All P is M.	A
	Some M is not S.	O
	No conclusion follows.	

In figure IV, AO combination cannot yield any conclusion because the middle term has not been distributed in either of the premises.

(5) EA	No P is M.	E
	All M is S.	A
	∴ Some S is not P.	O

In EA combination, in Figure IV, we find that the middle term is distributed both in the minor premise and the major premise. Since one premise is negative the conclusion must be negative. But the conclusion cannot be an E proposition to avoid the fallacy of illicit minor. The conclusion can be O proposition. The major term is distributed in the conclusion which is also distributed in the major premise. So no illicit process is involved. Thus EAO is a valid mood in the fourth figure. It is technically called FESAPO.

(6) EI	No P is M.	E
	Some M is S.	I
	∴ Some S is not P.	O

In figure IV, EI combination is free from the fallacy of undistributed middle since the middle term is distributed in the major premise. Since one premise is negative the conclusion will be negative. The conclusion cannot be E proposition since the minor term which is not distributed in the minor premise will be distributed in the conclusion. But the conclusion can be O proposition. The major term is distributed in the conclusion which is also distributed in the major premise. So no illicit process will be involved. Thus EIO is a valid mood in fourth figure and it is technically called FRESISON.

(7) IA	Some P is M.	I
	All M is S.	A
	∴ Some S is P.	I

In IA combination, the middle term is distributed in the minor premise. Since both the premises are affirmative and one premise (major premise) is particular, the conclusion will be affirmaitve and particular or I proposition. Since I proposition does not distribute any term no illicit process will be involved. Thus IAI is a valid mood in figure IV. It is named as DIMARIS.

(8) OA	Some P is not M.	O
	All M is S.	A
	∴ No conclusion follows.	

In OA combination, the middle term is distributed in both the premises. Since one premise (major) is particular and negative, the conclusion (if any) will be particular and negative or O proposition. In that case the major term (the predicate of the conclusion) will be distributed which is not distributed in the major premise (being the subject of a particular proposition). So no valid conclusion follows.

In figure IV the valid moods are BRAMANTIP, CAMENES, FESAPO, FRESISON and DIMARIS. They are five in number.

We give below the list of valid moods in different figures at a glance.

First Figure- BARBARA, CELARENT, DARII, FERIO

Second Figure- CAMESTRES, CESARE, BAROCO, FESTINO

Third Figure- DARAPTI, DATISI, DISAMIS, FELAPTON, FERISON, BOCARDO

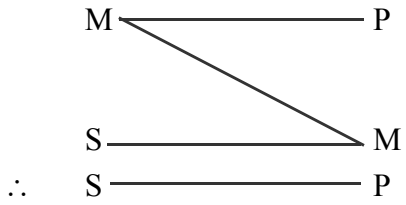
Fourth Figure- BRAMANTIP, CAMENES, DIMARIS, FESAPO, FRESISON

We notice that there are in all 19 valid moods in the four figures. The first figure has four valid moods, the second figure also has four valid moods. The third figure contains six valid moods and the fourth figure has five valid moods.

2.7 Special Syllogistic Rules :

Besides the general syllogistic rules by which the valid moods of the different figures are determined, there are special syllogistic rules for each figure. With the help of the special rules of any figure we can determine the valid moods in that figure. The special rules of different figures can be proved by the help of general syllogistic rules.

Special Syllogistic Rules for First Figure:-



(1) The major premise must be universal.

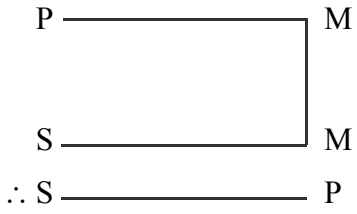
(2) The minor premise must be affirmative.

PROOF :

Rule 1: If the major premise is not universal,then it will be particular. In that case the middle term (being the subject of particular major) will not be distributed. In order to avoid the fallacy of undistributed middle, it must be distributed in the minor premise. So the minor premise must be negative. If the minor premise is negative, the major premise must be affirmative and the conclusion must be negative. If the conclusion is negative the major term will be distributed which is not distributed in the major premise. Thus the fallacy of illicit major will be committed. Therefore, the major premise cannot be particular, it must be universal.

Rule-2: If the minor premise is not affirmative, then it will be negative. If the minor premise is negative, obviously the major premise is affirmative and the conclusion will be negative. If the conclusion is negative, the major term will be distributed which is not distributed in the major premise. So the fallacy of illicit major will be committed. Thus the minor premise cannot be negative, it must be affirmative.

Special Syllogistic Rules for Second Figure :-



1) The major premise must be universal.

2) One of the premises must be negative.

3) The conclusion must be always negative.

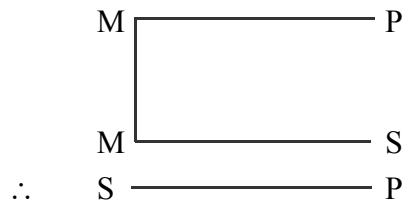
PROOF:

1) If the major premise is not universal, let it be particular. If the major premise is particular, the major term will not be distributed, so the major term cannot be distributed in the conclusion. So the conclusion must be affirmative. If the conclusion is affirmative, it is obvious that both the premises must be affirmative and the middle term (being the predicate in both the premises), cannot be distributed in either of the premises. So on the supposition that the major premise is particular in the second figure the fallacy of undistributed middle will be committed. Therefore, the major premise must be universal.

2) One of the premises must be negative so that the middle term is distributed at least once in order to avoid the fallacy of undistributed middle.This is because the middle term is the predicate in both premises and only a negative proposition distributes its predicate.

3) If the conclusion is not negative, it would be affirmative. If the conclusion is affirmative, then both the premises are affirmative, as a result of which middle term cannot be distributed at least once and the fallacy of undistributed middle will be committed. Thus the conclusion must be negative.

Special Syllogistic Rules for Third Figure :-



(1) Minor premise must be affirmative.

(2) One of the premises must be universal.

(3) Conclusion must be particular.

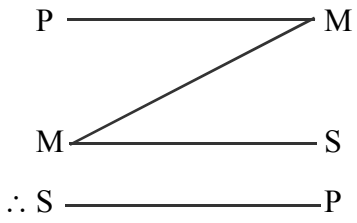
PROOF :

(1) If the minor premise is not affirmative, let it be negative. As a result of it, the conclusion will be negative and the major premise must be affirmative. When the conclusion is negative, the major term is distributed which is not distributed in the major premise. (being the predicate of the affirmative major premise). So the fallacy of illicit major will be committed. Therefore, the minor premise must be affirmative.

(2) In the thrid figure the middle term is the subject in both the premises. Since only universal propositions distribute their subjects, one of the premises must be universal in order to enable the middle term to be distributed at least once and thereby to avoid the fallacy of undistributed middle.

(3) If the conclusion is not particular, let it be universal. If the conclusion is universal, the minor term will be distributed and in that case it must have to be distributed in the minor premise. So the minor premise must be a negative proposition and the major premise be an affirmative proposition. The conclusion will be negative. If the conclusion is negative the major term is distributed in the conclusion which is not distributed in the major premise. The fallacy of illicit major will be committed. Therefore, the conclusion must be particular.

Special Syllogistic Rules for Figure - IV



(1) If the major premise is affirmative, the minor premise must be universal.

(2) If the minor premise is affirmative, the **conclusion must be particular.**

(3) If either premise is negative, the major premise must be universal.

PROOF :

(1) If the major premise is affirmative, the middle term being its predicate will not be distributed. So it must be distributed in the minor premise(in order to avoid the fallacy of undistributed middle). Since the middle term occupies the position of subject in the minor premise, the minor premise must be universal.

(2) If the minor premise is affirmative, the minor term will not be distributed as it occupies the place of predicate. Thus the minor term cannot be distributed in the conclusion to avoid the fallacy of illicit minor. Hence it must be a particular proposition.

(3) If any of the premise is negative, the conclusion is bound to be negative. As a result of this, the major term will be distributed in the conclusion. In order to avoid the fallacy of illicit major, the major term in the major premise must be distributed. Hence the major premise must be universal.

2.8 Aristotle's Dictum:

According to Aristotle, the first figure is the perfect figure because the validity of the moods of this figure can be directly tested by a principle which is self-evident. This principle is known as the *Dictum de Omni et Nullo*. It literally means '*a statement concerning all and none*'. The Dictum states that 'what is said of All or None may be said of anything contained therein'.

The dictum can be expressed as follows:

Whatever is affirmed or denied of a whole class may be affirmed or denied of everything contained in that class.

The same principle has also been stated in the following manners.

Whatever is predicated (affirmed or denied) universally of any class of things, may be predicated in the like manner (affirmed or denied) of anything comprehended in that class.

The dictum can be analysed into three parts (in the form of a syllogism).

1. Anything whatever predicated of a term distributed. (The major premise). 'All or No M is P'.
2. Under which term something else is contained. (The minor premise 'S is M').

3. May be predicated (in the like manner) of that which is so contained. (The conclusion) S is P.

We can illustrate the application of the dictum with the help of some examples.

1. All children are inquistive.

   Sweta is a child.

   Therefore, Sweta is inquistive.

2. No man is perfect.

   Sushant is a man

   Therefore, Sushant is not perfect.

In the first example, we attribute the quality of being inquistive to all children. In the minor premise, we affirm that Sweta is a member of the class 'children'. In the conclusion, by applyng the rule, we affirm that Sweta is inquistive. Likewise, in the second example, perfection is denied of the whole class of men. The minor premise (Sushant is a man.) affirms that Sushant is included in the class of man. In the conclusion, the quality of being perfect is denied of Sushant who is a member of the class 'man'. We notice that in the above examples the major premise is universal, the minor premise is affirmative and the quality of the conclusion is determined by the quality of the major premise. Notice that these are the special features of the first figure.

We can notice that the principle directly applies only to the first figure of syllogism. In the first figure the pattern of argument is that some general rule is applied to a particular case. The major premise states a general principle. (either affirmative or negative) the minor premise states that some particular case comes under this principle, and the conclusion applies the general principle to the particular case. Thus the dictum directly applies to the valid modes of the first figure (BARBARA, CELARENT, DARII and FERIO). So the first figure is regarded as the perfect figure. The other figures are said to be imperfect figures from the standpoint of Aristotle's dictum.

2.9 Reduction : Direct and Indirect

We have seen that Aristotle's dictum applies directly only to the first figure. So the first figure is called the perfect figure where as second, third and fourth figures are called imperfect figures. Consequently, the valid moods of first figure (BARBARA, CELARENT, DARII and

FERIO) are known as perfect moods and the valid moods of other figures are called imperfect moods. However, it is possible to transform any imperfect mood into perfect mood by a process called reduction. We thus define reduction as a process of transforming an imperfect mood into perfect mood. In reduction we prove the validity of an imperfect mood by using the validity of perfect moods. Reduction is of two types, namely, direct and indirect. Direct reduction is a process of transforming an imperfect mood into perfect mood by the application of either conversion, observsion or interchanging the place of major and minor premises. On the other hand, indirect reduction consists of proving the validity of imperfect mood by using "the principle of *reductio ad absurdum*" together with the validity of perfect moods. We discuss and explain below each of them in detail.

Note that Aristotle's dictum is an intuitively valid principle. Since it applies directly to the moods namely 'AAA', EAE, AII and EIO (i.e. BARBARA, CELARENT, DARII and FERIO) of first figure such moods are valid moods. Then Aristotle proved the validity of moods belonging to the imperfect figures by using the valid moods of first figure. The method of reduction was used by Aristotle to prove the imperfect syllogistic moods. Earlier we tested the validity of syllogistic moods either by using "General syllogistic rules" or by "Special syllogistic rules". All these ways of proving syllogistic moods are nothing but alternative ways of proving the same thing. Moreover, since imperfect moods are reduced to perfect moods, we may say that reduction as a method of proof reveals the unity of all forms of syllogistic inference.

For easy remembering of valid syllogistic moods, the mnemonic verses have been composed. These are composed of fictitious words indicating valid syllogistic moods and at the same time they carry instructions with respect to reduction of syllogistic moods of second, third and fourth figure to those of the first figure. As already discussed, the first figure and the second figure have each four valid moods. The third figure contains six valid moods and the fourth figure has five valid moods. For convenience we state below all the valid syllogistic moods in a mnemonic verse.

First Figure- BARBARA, CELARENT, DARII, FERIO

Second Figure- CEMESTRES, CESARE, BAROCO, FESTINO

Third Figure- DARAPTI, DATISI, DISAMIS, FELAPTON, FERISON, BOCARDO

Fourth Figure- BRAMANTIP, CAMENES, DIMARIS, FESAPO, FRESISON

Here each word in our mnemonic verse represents a valid syllogistic mood in the figure written by its side. For example, the word 'BARBARA' is the name of a valid syllogistic mood in the first figure. Similarly 'DARAPTI' is the name of a valid mood in third figure and so on. In each of these words we find three vowels. The first and second vowels reprectively denote the major and minor premise. The last vowel represents the conclusion. For example the mood CELARENT in first figure contains three vowels namely "E A E". The first vowel "E" indicates that the major premise in the above mood is an E-proposition, the second vowel 'A' indicates that the minor premise is an A-proposition, and the third vowel "E" indicates that the conclusion is an E-proposition. Analogously we understand the presence of three vowels in other syllogistic moods. The initial letters of the moods of the first figure are the first four consonants 'B', 'C', 'D' and 'F'. The initial consonant of the moods of the imperfect figures (except BAROCO and BOCARDO) indicates that the mood is to be reduced to the perfect mood having the same initial consonant. For example, the first initial consonant "D" of the mood DARAPTI in third figure indicates that the mood in question is to be reduced to the mood of the first figure having the same initial consonant. In other words, the mood DARAPTI in third figure is to be reduced to DARII in first figure. Similarly, since the initial consonant of CESARE in second figure is same as that of the initial consonant of CELARENT in first figure. So CESARE is to be reduced to CELARENT; in first figure and so on.

We interprete other consonants such as 'S', 'P', 'M', 'K' and 'C' occuring in the syllogistic moods as given below. But the letters such as 'R', 'T', 'L', 'B', 'D' and 'N' have no role in reduction. They have been used only to help pronunciation.

'S' denotes simple conversion of the proposition indicated by the preceeding vowel.

'P' denotes conversion per limitation of the propsotion indicated by the preceding vowel.

We note that if 'S' or 'P' occurs after the third vowel then the conclusion of the new syllogism admits either simple conversion or conversion per limitation according to situation.

'M' indicates the interchange of place of major and minor premises i.e. the major premise of the given syllogism becomes the minor premise of our new syllogism in first figure and the minor premise of the given syllogism becomes the major premise of the new syllogism in first figure.

'K' deonotes obversion applied to the preceeding proposition.

Now we may understand 'KS' as first apply obversion to the preceeding proposition then apply simple conversion. Similarly, 'SK' indicates that first apply simple conversion then apply obversion to the result. Note that although 'KS' and 'SK' do not occur in the mnemonic verse, yet they will occur in the renaming of BAROCO and BOCARDO as FAKSOKO and DOKSAMOSK. (see page 164 below.)

Further if the consonant C is used not as an initial letter then the letter 'C' indicates that the mood in question is to be reduced by the help of its changed name. This situation holds only with respect to BAROCO in second figure and BOCARDO in third figure. After explaining technical role of the occurence vowels and consonants in the names of the moods in our mnemonic verses, let us illustrate direct reduction of imperfect moods.

(a) Direct reduction of second figure valid moods to first figure.

CESARE :

Note that the mood CESARE is an imperfect mood belonging to the second figure. Since the initial letter of this mood is 'C', it is to be reduced to the mood 'CELARENT' in first figure. Moreover, as the letter 'C' does not occur in the mood except as the initial letter, it is to be reduced directly to 'CELARENT'. The direct reduction of CESARE is shown as given below.

CESARE		**CELARENT**
(Second figure)		**(First figure)**
E No P is M	$\xrightarrow{\text{by S}}$	E No M is P
A All S is M	$\xrightarrow{\text{taken as it is}}$	A All S is M
$\therefore$ E No S is P		$\therefore$ E No S is P

Note that the major premise of CESARE is an E-proposition of the form "No P is M", which is followed by the letter 'S'. So we apply simple conversion to it yielding an E-proposition "No M is P". This is indicated by the arrow starting from the major premise of CESARE and ending with the major premise of 'CELARENT' as shown above. To construct the mood in first figure, there is no need to apply anything to the minor premise of CESARE i.e. the minor premise

of CESARE is taken as it is to form the minor premise in first figure. As a result the new mood "E A E" (i.e. CELARENT in first figure) is formed as shown above. Therefore, we notice that the imperfect mood CESARE is directly reduced to "CELARENT" in first figure.

Analogous explanation of direct reduction of an imperfect mood to a perfect mood can easily be given. In what follows we carry out direct reduction without giving explantion. The explanatory part is left for students to practice.

CAMESTRES :

CAMESTRES (Second figure)			**CELARENT (First figure)**	
A	All P is M	by M →	E	No M is S
E	No S is M	by M, S →	A	All P is M
∴ E	No S is P		∴ E	No P is S
			∴ E	No S is P (by S)

FESTINO :

FESTINO (Second figure)		**FERIO (First figure)**
E No P is M	by S →	E No M is P
I Some S is M	taken as it is →	I Some S is M
∴ O Some S is not P		∴ O Some S is not P

(b) Direct reduction of third figure valid moods to first figure.

1) DARAPTI :

DARAPTI (Second figure)			**DARII (First figure)**	
A	All M is P	taken as it is →	A	All M is P
A	All M is S	by P →	I	Some S is M
∴ I	Some S is P		∴ I	Some S is P

2. DISAMIS

DISAMIS (Third figure)		**DARII** (First figure)
I Some M is P	by M, S	A All M is S
A All M is S	by M	I Some P is M
∴ I Some S is P		∴ I Some P is S
		∴ I Some S is P (by S)

3. DATISI

DATISI (Third figure)		**DARII** (First figure)
I All M is P	taken as it is	A All M is P
I Some M is S	by S	I Some S is M
∴ I Some S is P		∴ Some S is P

4. FELAPTON

FELAPTON (Third figure)		**FERIO** (First figure)
E No M is P	taken as it is	E No M is P
A All M is S	by P	I Some S is M
∴ O Some S is not P		∴ O Some S is not P

5. FERISON

FERISON (Thrid figure)		**FERIO** (First figure)
E No M is P		E No M is P
I Some M is P	by S	I Some S is M
∴ O Some S is not P		∴ O Some S is not P

(c) Direct reduction of foruth figure valid moods to first figure.

1. BRAMANTIP :

BRAMANTIP		**BARBARA**
(Fourth figure)		**(First figure)**
A All P is M	by M →	A All M is S
A All M is S	← by M	A All P is M
∴ A All S is P		∴ A All P is S
		∴ I Some S is P (by P)

2. CAMENES

CAMENES		**CELARENT**
(Fourth figure)		**(First figure)**
A All P is M	by M →	E No M is S
E No M is S	← by M	A All P is M
∴ E No S is P		∴ E No P is S
		∴ E No S is P (by S)

3. DIMARIS

DIMARIS		**DARII**
(Fourth figure)		**(First figure)**
I Some P is M	by M →	A All M is S
A All M is S	← by M	I Some P is M
∴ I Some S is P		∴ I Some P is S
		∴ I Some S is P (by S)

4. FESAPO

FESAPO		**FERIO**
(Fourth figure)		**(First figure)**
E No P is M	by S →	E No M is P
A All M is S	by P →	I Some S is M
∴ O Some S is not P		∴ O Some S is not P

5. FRESISON

FRESISON		**BARBARA**
(Fourth figure)		**(First figure)**
E No P is M	by S	E No M is P
A Some M is S	by P	I Some S is M
∴ O Some S is not P		∴ O Some S is not P

(d) Direct Reduction of BAROCO And BOCARDO:

Note that for Aristotle the moods BAROCO in second figure and BOCARDO in third figure cannot be reduced to first figure because he did not recognise obversion as a valid inferential process. This is so as it involves use of infinite terms. Since we recognise obversion as a valid process of immediate inference, we may reduce BAROCO and BOCARDO to first figure. For this let us rename BAROCO and BOCARDO as FAKSOKO and DOKSAMOSK respectively.

1. BAROCO (Renamed as FAKSOKO)

FAKSOKO (BAROCO)		**FERIO**
(Second figure)		**(First figure)**
A All P is M	by KS	E No not -M is P
O Some S is not M	by K	I Some S is not -M
∴ O Some S is not P		∴ O Some S is not P

2. BACARDO (Renamed as DOKSAMOSK)

DOKSAMOSK (BACARDO)		**DARII**
(Third figure)		**(First figure)**
O Some M is not P	by M, KS	A All M is S
A All M is S	by M	I Some not -P is M
∴ O Some S is not P		∴ I Some not -P is S
		∴ I Some S is not -P by S (simple conversion)
		∴ O Some S is not P by K (obversion)

(e) Indirect Reduction:

We have noted that Aristotle did not reduce the moods BAROCO and BOCARDO directly because the direct reduction of these moods essentially involves the process of obversion and Aristotle did not recognise obversion as a valid process as it involved the use of infinite term. He employed the method of indirect reduction to reduce BAROCO and BOCARDO to first figure. But the method of indirect reduction is universal in application. It can be used in all cases of imperfect moods of second, third and fourth figures.

Indirect reduction consists of proving the validity of any imperfect mood by using a first figure mood together with the principle of *Reductio ad absurdum*. *Reductio ad absurdum* states that if a contradiction syllogistically follows from the set of premises together with the denial of the conclusion then the original conclusion follows from the set of premises alone. In other words, indirect reduction involves the derivation of a contradiction from the truth of the premises together with the falsity of the conclusion by using first figure moods. Let us apply indirect reduction to the mood BAROCO in second figure.

I Indirect Reduction of BAROCO in Second Figure:

We know that the mood BAROCO is an imperfect mood in second figure.Let us construct the argument

	1.	A	All P is M.	Major premise.
	2.	O	Some S is not M.	Minor premise.
∴	3.	O	Some S is not P.	Conclusion.

BAROCO - 2 (i.e. BAROCO is a mood in second figure)

We wish to reduce it indirectly to first figure. For this, assume that BAROCO is invalid and derive syllogistically a contradiction by using a perfect mood. Since BAROCO by hypothesis is invalid, its premises i.e. (1) All P is M and (2) Some S is not M being true the conclusion, (3) Some S is not P, is false. Since (3) is false, its contradictory i.e. (4) All S is P must be true. Then by using (I) as the major premise and (4) as the minor premise and considering 'P' as our middle term we construct syllogistic mood BARBARA as given below.

	(1)	A	All P is M	Major premise
	(4)	A	All S is P	Minor premise
				BARBARA
∴	(5)	A	All S is M	Conclusion.

Since (1) and (4) are true and the mood BARBARA is a valid syllogistic mood in first figure, the conclusion (5) All S is M must be true. But, now the truth of (5) contradicts the truth of (2) (i.e. (5) A "All S is M" and (2) O "Some S is M" are contradictories of each other). Thus, this contradiction proves the validity of BAROCO. Note that in this proof we use the mood BARBARA-1. So we conclude that the mood BAROCO-2 is reduced to BARBARA-1. This completes the indirect reduction of BAROCO.

II. Indirect Reduction of BOCARDO in Third Figure :

BOCARDO-3 is an imperfect mood belonging to third figure as given below :

	(1)	O	Some M is not P	Major premise.
	(2)	A	All M is S	Minor premise.
∴	(3)	O	Some S is not P	Conclusion

BOCARDO - 3

For an indirect reduction let us assume that the mood BOCARDO is invalid. Hence its premises i.e. (1) Some M is not P and (2) All M is S being true but the conclusion (3) Some S is not P can be false. Since (3) is false, its contradictory (4) All S is P must be true. Then by considering (4) as the major premise, (2) as the minor premise and 'S' being our middle term, we construct below the syllogistic mood BARBARA.

	(4)	A	All S is P	Major premise.
	(2)	A	All M is S	Minor premise.
				BARBARA
∴	(5)	A	All M is P	Conclusion

Since (4) and (2) are true by hypothesis and the mood BARBARA-1 is valid the conclusion (5) All M is P must be true. But the truth of (5) contradicts the truth of (1), (i.e. "All M is P" and "Some M is not P" are contradictories of each other). This contradiction proves the validity of BOCARDO - 3. Since in this proof we use the mood BARBARA-1, we conclude that the mood BOCARDO-3 is reduced indirectly to the BARBARA in first figure. This completes the indirect reduction of BOCARDO.

III. Indirect Reduction of CESARE in Second Figure:

CESARE - 2 is an imperfect mood is second figure that may be stated as given below:

	(1)	E	No P is M.	Major premise.
	(2)	A	All S is M.	Minor premise.
∴	(3)	E	No S is P.	Conclusion.

We wish to reduce CESARE- 2 indirectly to first figure. For this, assume the invalidity of CESARE. Hence its premises (1) No P is M and (2) All S is M being true but the conclusion (3) No S is P can be false. Since (3) can be false, its contradictory (4) Some S is P is true. Then by taking (1) as the major premise and (4) as the minor premise and considering 'P' as the middle term we construct a valid syllogism in first figure as given below :

	(1)	E	No P is M	Major premise.
	(4)	I	Some S is P	Minor premise.
				FERIO - 1
∴	(5)	O	Some S is not P	Conclusion

Since (1) and (4) are true and FERIO is a valid syllogistic mood in first figure, (5) Some S is not M must be true. The truth of (5) contradicts the truth of (2) (i.e. Some S is not M and All S is M are contradictories). This contradiction proves the validity of CESARE. Since, here we use validity of FERIO - 1, we conclude that the imperfect mood CESARE-2 is reduced to FERIO- 1 indirectly. This completes the indirect reduction of CESARE-2.

IV. Indirect Reduction of DARAPTI in Third Figure :

Consider the mood DARAPTI in third figure as given below :

	(1)	A	All M is P	Major premise.
	(2)	A	All M is S	Minor premise.
∴	(3)	I	Some S is P	Conclusion.

We wish to reduce indirectly the above mood to a mood in first figure. For this let us assume that the mood DARAPTI - 3 is invalid. Hence, its premises being true, the conclusion could be false. In other words, (1) All M is P and (2) All M is S being true, (3) Some S is P is

could be false. Then since (3) is false, its contradictory (4) No S is P must be true. Now we construct below the mood CELARENT in first figure by taking (4) No S is P as the major premise, (2) All M is S as the minor premise and 'S' as the middle term.

(4)	No	S is P - E	Major premise
(2)	All	M is S - A	Minor premise
			CELARENT
(5)	No	M is P - E	Conclusion.

Since (4) and (2) are true and the mood CELARENT is a valid syllogistic mood, (5) No M is P must be true. But the truth of (5) contradicts the truth (1) All M is P because (1) and (5) are contrary to each other. So both cannot be true together. This contradiction proves that DARAPTI is a valid mood. Since its validity is proved by using the mood CELARENT in first figure, we conclude that DARAPTI is reduced to CELARENT indirectly.

V. Indirect Reduction of BRAMANTIP in Fourth Figure :

Let us consider the mood BRAMANTIP in fourth figure.

	(1)	A	All P is M.	Mjaor premise.
	(2)	A	All M is S.	Minor premise.
∴	(3)	I	Some S is P.	Conclusion.

BRAMANTIP - 4 :

For indirect reduction, let us assume that BRAMANTIP be invalid. Hence its premises (1) All P is M and (2) All M is S being true but the conclusion (3) Some S is P can be false. Then (4) No S is P must be true as (4) is the contradictory of (3). Then we construct below a mood CELARENT in first figure by taking (4) No S is P as the major premise, (2) All M is S as the minor premise and 'S' as the middle term.

(4)	E	No S is P.	Major premise.
(2)	A	All M is S.	Minor premise.
			CELARENT
(5)	E	No M is P.	Conclusion.

Since (4) and (2) are true and CELARENT is a valid mood in first figure, (5) "No M is P" must be true. Then (6) No P is M must be true because (6) is the converse of (5). Now (1) and (6) cannot be true together as both are contrary of each other. This proves that the mood BRAMANTIP in fourth figure is valid. Since its validity depends on the validity of CELARENT in first figure, we conclude that BRAMANTIP - 4 is reduced indirectly to CELARENT.

Note that by using the analogous reasoning we reduce indirectly rest of the imperfect mood to perfect moods.

2.10 Testing of Syllogistic Moods by Venn Diagram :

In this section we explain a testing procedure for Aristotle's syllogistic moods by Venn diagram. For this, we first explain the construction procedure of Venn diagram for a given syllogistic mood. To construct a Venn diagram for a syllogistic mood we follow the following instructions. Firstly, we translate, by the procedure explained earlier, the given syllogistic mood in Boolean notation. Since any syllogistic mood by definition contains exactly three distinct terms, we construct the Venn diagram by drawing three intersecting circles within a rectangle, where each circle represents a class and the rectangle denotes the universe of discourse. To name a circle we use English capital letters A, B, C, **...** etc. on any side of the circle. Further we write 'V' on the right top corner of the rectangle to indicate the domain of discourse.

Note that a Venn diagram with three intersecting circles within a rectangle divides the universe of discourse V into eight possible mutually exclusive regions as shown below.

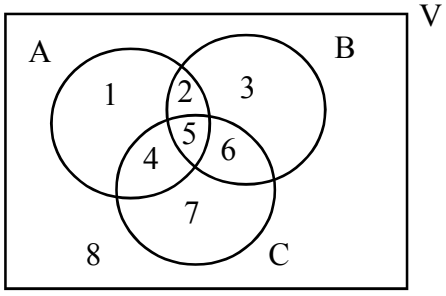


Figure - 1

We refer to a region in a Venn diagram by a device called encircled numbers. An encircled number 'ⓝ', (where 'n' is any possitive integer) denotes a region in the Venn diagram as specified by a straight line starting from 'ⓝ' and ending in region. Thus, in the following diagram.,'①' denotes a region as specified by a straight line starting from '①'.

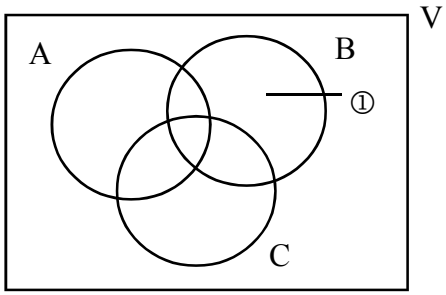


Figure - 2

Further, we already know that the shading indicates emptiness and 'linked-crosses' or 'cross' indicates non-emptiness. If a particular region contains both shading and a cross (or linked-crosses) then we stipulate that shading dominates a cross. But there is one set of circumstances in which we do not want to say that shading dominates a cross. The circumstance is as follows. "When every cross in a linkage of crosses is covered by shading, we hold that the diagram is inconsistent rather than holding it to be empty. We define an argument to be valid if and only if the Venn diagrammatic representation of the premises automatically represents the conclusion. This means that in case of valid syllogistic argument the representation of the conclusion by use of Venn diagram is automatically achieved while drawing the Venn diagram for the premises. Otherwise the argument is invalid.

In addition to this characterization of validity, there is another way a characterizing validity which may be described as follow. As stated above we call a Venn diagram inconsistent if all the crosses are covered by shading, otherwise Venn diagram is called consistent. An argument is

valid if and only if the Venn diagrammatic representation of the premises together with the denial of the conclusion leads to an inconsistent Venn diagram. Otherwise, the argument is called invalid. The former description of testing validity is direct method of testing validity and the latter is called indirect method of testing validity by Venn diagram. Now we may proceed to test the validity of syllogistic moods both directly and indirectly by using Venn diagram.

We may note that the expression "AAA – 1" denotes a mood in first figure such that its major premise, minor premise and the conclusion are A-propositions. This mood is known as Barbara. Accordingly, we use analogous expression to denote any mood in any figure. For example, the mood Disamis in the third figure may be denoted by the expression "IAI – 3". In this mood the major premise is an I-proposition the minor premise is an A-proposition and the conclusion is an I-proposition. '3' indicates that this mood belongs to third figure.

Testing of "AAA – 1" :

The mood Barbara belongs to first figure with the following structure.

(1)	A All M is P	Premise
(2)	A All S is M	Premise
(3)	$\therefore$ A All S is P	Conclusion.

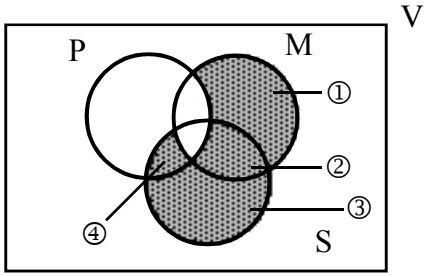
As required, we first translate the above mood in Boolean notation as given below:

(1)	$M \cap -P = O$	Premise
(2)	$S \cap -M = O$	Premise
(3)	$\therefore S \cap -P = O$	Conclusion

Direct Method :

To prove the validity of AAA–1, we draw the Venn diagram for the premises and then see whether the conclusion has been automatically represented while representing the premises or not. If the conclusion is already represented while representing the premises by use of Venn diagram, the mood in question is valid. Otherwise it is invalid. Let us represent

below the premises and the conclusion of the mood separately.

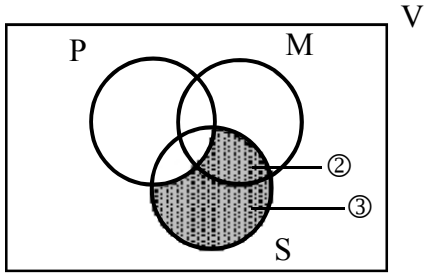


Representation of premises

(1) M $\cap$ –P = O (Major premise)

(2) S $\cap$ –M = O (Minor premise)

Figure - 3



Represention of the conclusion.

(3) S $\cap$ – P = O

Figure - 4

In figure 3 we represent the premises such that the representation of major premise leads to shading of the regions ① and ② and similarly the representation of the minor premise leads to shading of the regions ③ and ④. The representation of the conclusion in figure-4 leads to shading of the regions ② and ③. Thus we note that the conclusion has been automatically represented while representing the premises as we have already shadeed the regions ② and ③ while representing the premises. Therefore, the mood AAA–1 is a valid mood.

Indirect method of testing AAA–1

To prove the validity of AAA–1 indirectly we have to show that the Venn diagrammatic representation of the premises together with the denial of the conclusion leads to an inconsistent Venn diagram. The denial of the conclusion (3) All S is P (S $\cap$ – P = O) is (4) Some S is not P or S $\cap$ – P $\neq$ O. Now let us construct a Venn diagram for (1), (2) and (4) and see whether the diagram so constructed is inconsistent or not.

(1) M $\cap$ –P = O (Major premise)

(2) S $\cap$ –M = O (Minor premise)

(4) S $\cap$ – P $\neq$ O (Denial of the conclusion)

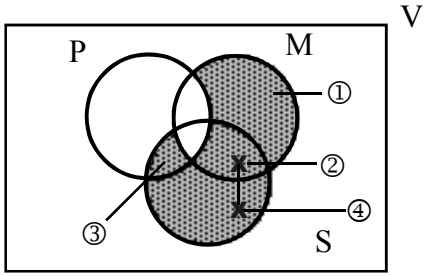


Figure - 5

The major premise is represented by shading the regions ① and ②. The minor premise is represented by shading the regions ③ and ④. The negation of the conclusion is represented by putting linked crosses in the regions ② and ④. We notice that all the linked crosses are shaded. Hence the above Venn diagram is inconsistent. Since the represention of the premises together with the negation of the counclusion resulted in an inconsistent diagram, the original argument AAA–1 is proved to be valid.

Testing of E A E –1

This mood belongs to the first figure with the following structure.

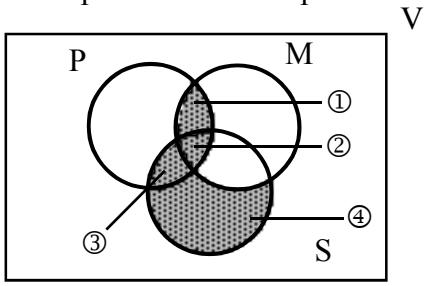
(1)	E No M is P.	Major premise
(2)	A All S is M.	Minor premise
(3)	∴ E No S is P.	Conclusion.

First we translate the above mood in Boolean notation as given below.

(1)	$M \cap P = O$	Major premise
(2)	$S \cap -M = O$	Minor premise
(3)	$\therefore S \cap P = O$	Conclusion.

Direct Method of Testing of EAE–1

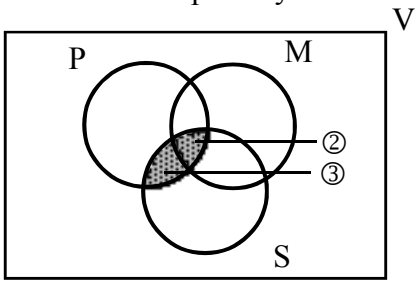
We represent below the premises as well as the conclusion separately.



(1) $M \cap P = O$ (Major premise)

(2) $S \cap -M = O$ (Minor premise)

Figure - 6



(3) $S \cap P = O$ (Conclusion)

Figure - 7

In figure-6 we represent the premises such that the representation of the major premise leads to the shading of the regions ① and ② and the representation of the minor premise leads to shading of the regions ③ and ④. The representation of the conclusion leads to shade the regions ② and ③ as shown in figure-7. Clearly the conclusion is already represented, while representing the premises. Therefore, the mood E A E in first figure is valid.

Indirect Method :

To prove its validity by use of indirect method let us represent the premises together with the denial of the conclusion by use of Venn diagram. Clearly, the denial of the conclusion is (4) $S \cap P \neq O$. Now we construct the required Venn diagram for (1) $M \cap P = O$ (2) $S \cap -M = O$ and (4) $S \cap P \neq O$ as follows.

(1) $M \cap -P = O$ (Major premise)

(2) $S \cap -M = O$ (Minor premise)

(4) $S \cap -P \neq O$ (Denial of the conclusion)

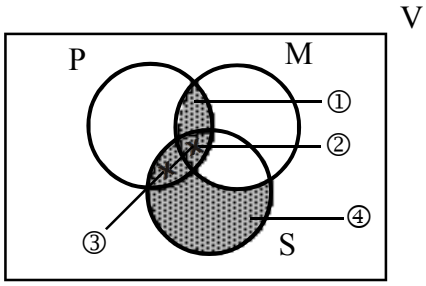


Figure - 8

Premise (1) leads to shading the regions ① and ②. Premise (2) leads to shading the regions ③ and ④. Further the assumption (4) leads to putting two linked crosses in the regions ② and ③. Hence all the crosses in linked have been shaded. Hence, the above Venn diagram is inconsistent. Therefore, the mood E A E in first figure is valid.

Testing of AII – 1

The mood AII – 1 belongs to the first figure having the following structure.

(1)	A	All M is P.	Major premise
(2)	I	Some S is M.	Minor premise
(3)	∴ I	Some S is P.	Conclusion

At the out set let us translate the mood in Boolean notation as given below.

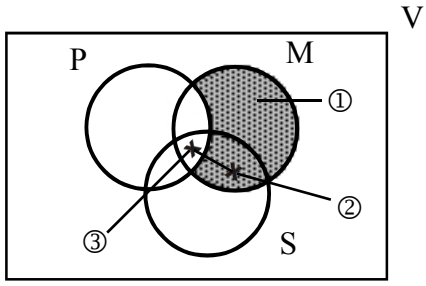
(1) $M \cap - P = O.$ (Major premise)

(2) $S \cap M \neq O.$ (Minor premise)

(3) $\therefore S \cap P \neq O.$ (Conclusion)

Direct Method :

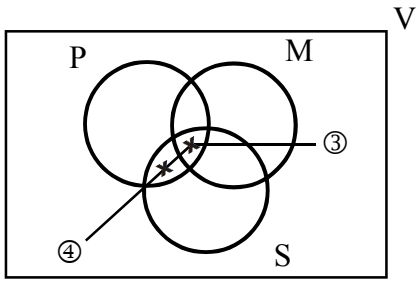
For this let us representent the premises and the conclusion of the mood by venn diagram separately.



(1) $M \cap - P = O$ (Major premise)

(2) $S \cap M \neq O$ (Minor premise)

Figure - 9



(3) $S \cap P \neq O$ (Conclusion)

Figure - 10

In figure 9 the major premise leads to shading of the regions ① and ②. So also the minor premise leads to place two linked crosses in the regions ② and ③. In the conclusion two linked crosses are placed in the regions ③ and ④ as shown in the figure-10. This means that the regions ③ and ④ are non-empty. Now the conclusion is clearly implied by the premises. Because, by specifying the region ③ as non-empty, we obviously specify that for any region that includes it is non-empty. In the present case the conclusion asserts that the region consisting of ③ and ④ is non-empty. Thus, the conclusion gets represented while representing the premises. Hence the mood AII is a valid mood in the first figure.

Indirect method

To prove the validity of the above mood indirectly let us represent the premises together with the denial of the conclusion by Venn diagram. The denial of the conclusion is (4) $S \cap P = O$. Now we may construct the Venn diagram for (1) $M \cap -P = O$ (2) $S \cap M \neq O$ and (4) $S \cap P = O$ as follows

(1) $M \cap -P = O$ (Major premise)

(2) $S \cap M \neq O$ (Minor premise)

(4) $S \cap P = O$ (Denial of the conclusion)

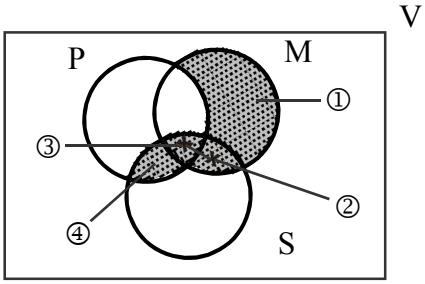


Figure - 11

The Venn diagramatic representation of Premise (1) leads to shading of the regions ① and ②. Premise (2) leads to place two linked crosses in the regions ② and ③. Finally assumption ④ leads to shading of the regions ③ and ④. In this diagram all the crosses in our linkage of crosses are shaded. Therefore, the diagram is inconsistent. Hence the mood AII-1 is valid.

Testing of syllogistic mood AAE – 1

Let us test a mood which is invalid.

The mood 'AAE – 1' belongs to the first figure with the following structure.

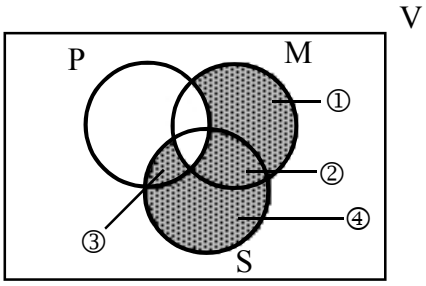
(1)	A	All M is P.	Major premise
(2)	A	All S is M.	Minor premise
(3)	E	No S is P.	Conclusion

We translate the above mood in Boolean notation as follows :

(1)	$M \cap - P = O$	(Major premise)
(2)	$S \cap - M = O$	(Minor premise)
(3)	$S \cap P = O$	(Conclusion)

Direct Method :

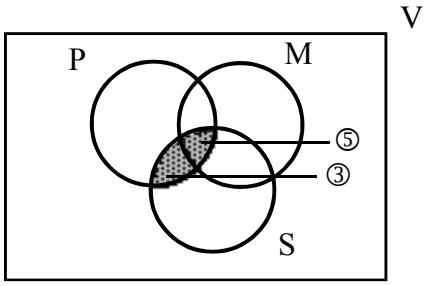
Let us represent below the premises as well as the conclusion of the mood AAE–1 by use of Venn diagram separately



(1) $M \cap - P = O$ (Major premise)

(2) $S \cap - M = O$ (Minor premise)

Figure - 12



(3) $S \cap P = O$ (Conclusion)

Figure - 13

The major premise leads to shading of the regions ① and ② and the minor premise leads to shading of the regions ③ and ④. But when we represent the conclusion by use of Venn diagram we shade the regions ③ and ⑤. Note that the region ⑤ has not been shaded by the premises whereas it has been shaded by the conclusion. Therefore the representation of the premises does not lead to automatic represention of the conclusion. Hence the mood in question is invalid.

Indirect Method :

To test the mood AAE-1 indirectly let us construct the Venn diagram for the premises together with denial of the conclusion as shown in the figure 14. The denial of the conclusion would be (4) $S \cap P \neq O$. We now construct Venn diagram for the following set of expressions.

(1) $M \cap - P = O$ (Major premise)

(2) $S \cap - M = O$ (Minor premise)

(4) $S \cap P \neq O$ (denial of the conclusion)

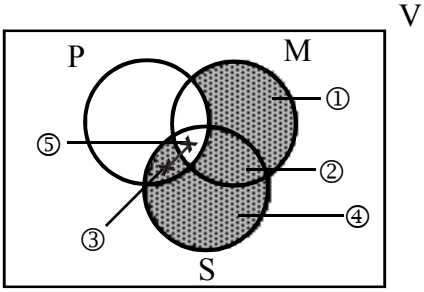


Figure - 14

The representation of major premise leads to shading of the region ① and ②, representation of the minor premise leads to shading of the regions ③ and ④. The denial of the conclusion leads to linked crosses in the regions ③ and ⑤. In this case all the crosses in the link have not been shadded. Therefore the Venn diagram is consistent. Since the representation of the premises together with the denial of the conclusion did not yield any inconsistency, the mood in question (AAE-1) is invalid.Note that by using the above method we can test all the invalid syllogistic moods as invalid.

Testing of the Syllogistic mood AAA in second figure (i.e. AAA-2) :

The mood AAA-2 belongs to the second figure with the following structure.

(1)	A All P is M.	Major premise
(2)	A All S is M.	Minor premise
(3) ∴	A All S is P.	Conclusion

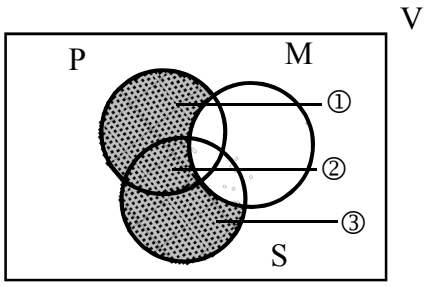
Here all the propositions including the conclusion are A-propositions. We translate below all these propositions into Boolean notation.

(1) P ∩ – M = O	Major premise
(2) S ∩ – M = O	Minor premise
(3) S ∩ – P = O	Conclusion

Let us construct below the Venn diagram to test the validity of AAA-2.

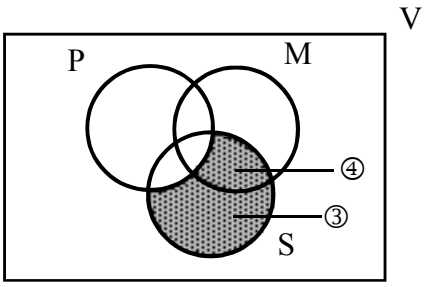
Testing of AAA-2 (Direct Method) :

For this we represent the premises and the conclusion of the mood AAA-2 separately by use of Venn diagram.



(1) P ∩ – M = O (Major premise)
(2) S ∩ – M = O (Minor premise)

Figure - 16



(3) S ∩ – P = O (Conclusion)

Figure - 17

In figure 16 the representation of the major premise leads to shading of the regions ① and ② and the representation of minor premise leads to shading of the regions ② and ③. On the other hand, in figure-17 the representation of the conclusion of the mood AAA-2 leads to shading of the regions ③ and ④. Since in the conclusion region ④ is shaded, which is not shaded while representing the premises the above mood (AAA–2) is invalid.

Indirect Method :

We can also test the same mood AAA–2 by use of indirect method. For this we construct below the Venn diagram representing the premises and the negation of the conclusion. Since $S \cap -P = O$ is our conclusion its denial would be (4) $S \cap - P \neq O$.

(1) $P \cap - M = O$ (Major premise)

(2) $S \cap - M = O$ (Minor premise)

(4) $S \cap - P \neq O$ (Denial of the conclusion)

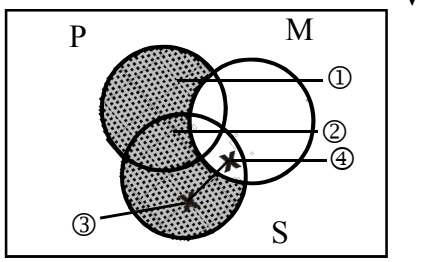


Figure - 18

In figure-18, the major premise leads to shading of the regions ① and ②. The minor premise leads to shading of the regions ② and ③. The representation of the denial of the conclusion leads to linked crosses in the regions ③ and ④ as shown in the above figure. Since in this Venn diagram all the crosses in the link have not been shaded, the Venn diagram is consistent. Therefore, the mood AAA-II in question is invalid.

Note that by use of venn diagrammatic method we can not test the validity of the moods namely AAI-3 (DARAPTI) and EAO-3 (FELAPTON) and AAI-4 (BRAMANTIP) and EAO-4 (FESAPO). This is so because in all these moods the premises are universal but the conclusions are particular. Since, in Boolean interpretation the universal propositions such as 'A' and 'E' have no existential import, whereas the particular propositions such as 'I' and 'O' have existential import, it does not permit derivation of propositions having existential import from the propositions having no existential import. Hence the validity of these four syllogistic moods cannot be verified by use of Venn diagram.

SUMMARY

Syllogism is a form of mediate deductive inference. A categorical syllogism has three terms. The subject term of the conclusion is called Minor term. The predicate term of the conclusion is called major term. The middle term appears in both the premises but not in the conclusion. The major term and the minor term are called as extremes. In a categorical syllogism, the major premise appears first, the minor premise second and the conclusion towards the last.

The mood of a syllogism is determined by the quality and quantity of the premises. There are 64 moods out of which only 19 moods are valid.

The figure of a syllogism is determined by the position of the middle term in the premises. In figure-I, the middle term is the subject term in the major premise and predicate term of the minor premise. In figure-II, the middle term is predicate of both the premises. In figure-III, middle term occupies the position of the subject of both the premises and in figure-IV, middle term is the predicate in major premise and the subject in minor premise. The logical form is the structure of a syllogism determined jointly by the mood and figure of a syllogism. There are ten general rules for standard form of syllogism. Some rules are fundamental whereas others are derivative. They may be summed up in the following manner.

Rule(1) -Every syllogism must have three and only three terms used in same sense throughout the argument. The violation leads to fallacy of four terms.

Rule(2) -Every syllogism must have three and only three propositions

Rule(3) -The middle term must be distributed at least in one premise. Violation of the rule leads to fallacy of undistributed middle.

Rule(4) - If either term is distributed in the conclusion it must be distributed in the respective premises. The violation of the rule leads to either fallacy of illicit major or fallacy of illicit minor.

Rule(5) - From two negative premises, no conclusion follows. The violation leads to fallacy of two negative premises or fallacy of exclusive premises.

Rule(6) - If one premise is negative, the conclusion is negative and vice-versa. The violation leads to fallacy of drawing an affirmative conclusion from a negative premise.

Rule(7) - If both premises are affirmative, the conclusion must be affirmative

Rule(8) - If both the premises are particular, no conclusion follows.

Rule(9) - If one premise is particular, the conclusion must be particular.

Rule(10) - From particular major and negative minor, no conclusion follows.

By application of these rules we get 19 valid moods. These are arranged according to the figures as follows :

First figure : BARBARA, CELARENT, DARII, FERIO

Second figure : CESARE, CAMESTRES, FESTINO, BAROCO

Third figure : DARAPTI, DISAMIS, DATISI, FELAPTON, BOCARDO, FERISON

Fourth figure : BRAMANTIP, CAMENES, DIMARIS, FESAPO, FRESISON

We have explained Aristotles's dictum de Omni et nullo. Since the dictum applies only to first figure directly, the first figure is called perfect figure. Other figures are called imperfect figures. The valid moods of first figure are called perfect moods and valid moods belonging to the other figures are called imperfect moods. Aristotle reduced imperfect moods to perfect moods by a process called reduction which consists of transforming an imperfect into a perfect mood. It is of two types namely direct and indirect. A direct reduction is a process of transforming an imperfect mood into perfect mood either by use of conversion or interchanging the major and minor premises or both where as in case of indirect reduction the principle of RAA is used to prove the validity of imperfect moods. In our final section we introduced Venn diagrammatic method of testing syllogistic moods. By use of this method we verify all the valid syllogistic moods except the moods DARAPTI, FELAPTON in third figure and BRAMANTIP and FESAPO in the fourth figure. Since in these moods the premises are universal and the conclusion is particular, universal, it does not permit the derivation of propositions having existential import from propositions having no existential import.

MODEL QUESTIONS

I. Point out which of the following are true and which are false.

1. The minor term is the subject of the conclusion.
2. The mood of a syllogism is found by checking the quality and quantity of the constituent proposition.
3. An A proposition can be a conclusion of a valid syllogism only in the first figure.
4. In the first figure of syllogism the middle term is in the predicate position in both he premises.
5. If all the terms are distributed in both the premises, then the syllogism cannot possibly be valid.
6. The vowels in the names of valid syllogisms, like BARBARA, stand for the syllogism's mood.
7. A valid syllogism with a negative conclusion must have one affirmative and one negative premise.
8. The main reason for indicating the figure of a syllogism is that we need to keep track of the position of the middle term in order to discriminate between syllogisms with identical moods.
9. A valid syllogism with the major and minor premises in the wrong order is also valid.
10. The middle term should be distributed in the conclusion.
11. It is permissible to derive a negative conclusion if a syllogism contains two negative premises.
12. In a Venn diagram 'X' mark in a region indicates that the region is empty.

II. Answer the following by choosing the correct option.

1. Out of the 64 moods by the four figures of syllogism, only

   (a) 32 are valid.

   (b) 19 are valid.

   (c) 26 are valid.

   (d) 16 are valid.

2. Which one of the following is the valid conclusion from "All Buddhists are vegetarians, and Some Oriyas are Buddhists"?

(a) All Odias are vegetarians.

(b) All vegetarians are Buddhists.

(c) Some Odias are vegetarians.

(d) None of the above.

3. Which one of the following is not correct?

(a) The first figure is the only figure which can have an A proposition as conclusion.

(b) The second figure can have only negative propositions as conclusion.

(c) The third figure can have only particular propositions as conclusion.

(d) The fourth figure can have any kind of proposition (A, E, I, or O) as conclusion.

4. In the following syllogism, which term is the middle term?

No babies are voters.

Some students are voters.

Therefore, some students are not babies.

(a) babies

(b) voters

(c) students

(d) Some students

5. What is the mood of the following syllogism?

Some snakes are not poisonous.

All snakes are creatures without legs.

Therefore, no creatures without legs are poisonous.

(a) OAO

(b) OAE

(c) IAO

(d) IAE

6. All ophthalmologists are doctors.
Some ophthalmologists are wealthy individuals.
Therefore, some wealthy individuals are doctors.
The mood of this syllogism is

(a) DARII

(b) DATISI

(c) DIMARIS

(d) DARAPTI

7. In constructing a Venn diagram, shading of a region is done to indicate that

(a) the region is nonempty.
(b) the region is empty.
(c) nothing can be said about the region.
(d) the syllogism is invalid.

8. Is any fallacy committed in the following syllogism?
All car owners are tax payers.
All tax payers are wealthy individuals.
Therefore, all wealthy individuals are car owners.

(a) It commits the fallacy of the undistributed middle.
(b) It commits the fallacy of illicit major.
(c) It commits the fallacy of illicit minor.
(d) No fallacy has been committed.

9. Is any fallacy committed in the following syllogism?

No criminals are trustworthy persons.

Some trustworthy persons are not lawyers.

Therefore, some lawyers are not criminals.

(a) It commits the fallacy of the undistributed middle.

(b) It commits the fallacy of illicit minor.

(c) It commits the fallacy of the illicit major.

(d) It commits the fallacy of exclusive premises.

10. The fallacy of illicit minor is committed when

(a) the predicate of the conclusion is distributed, but it is not distributed in the premise.

(b) the subject of the minor premise is not distributed.

(c) the minor premise does not contain any distributed terms.

(d) the subject of the conclusion is distributed, but it is not distributed in the premise.

11. What is wrong with the following argument?

All cardiologists are respected persons.

Some hospital employees are respected persons.

Therefore, some hospital employees are cardiologists.

(a) It commits the fallacy of illicit major.

(b) It commits the fallacy of undistributed middle.

(c) It commits the fallacy of illicit minor.

(d) Nothing is wrong with this argument.

12. Which of the following is NOT true of syllogistic arguments?

(a) If one premise is affirmative, the conclusion must be affirmative.

(b) If one premise is particular, the conclusion must be particular.

(c) If one premise is negative, the conclusion must be negative.

(d) If both the premises are negative, no conclusion follows.

13. The names such as BARBARA, CELARENT, DARII, FERIO are

(a) names of fallacies.

(b) pet names given by students to their favorite syllogisms.

(c) names of valid moods supplied by mnemonics.

(d) names of respected logicians.

14. Some doctors are not surgeons.

Some homeopaths are doctors.

Therefore, some homeopaths are not surgeons.

What is wrong with this argument?

(a) Nothing is wrong with this argument.

(b) This syllogism does not distribute the middle term.

(c) This syllogism has an undistributed minor premise.

(d) This syllogism has an undistributed major premise.

15. Is any fallacy committed in the following syllogism?

Some Oriyas are not entrepreneurs.

All Oriyas are Indians.

Therefore, some Indians are not entrepreneurs.

(a) This syllogism commits the fallacy of the undistributed middle.

(b) This syllogism commits the fallacy of illicit minor.

(c) This syllogism commits the fallacy of illicit major.

(d) No fallacy has been committed. The argument is valid.

III. Point out in each case whether the argument is valid or not. If the argument is invalid, name a fallacy committed.

1. All men are mortal.

   All men are rational beings.

   Therefore, all rational beings are mortal.

2. No one held for murder is given bail.

   Asok is not held for murder.

   Therefore, Asok is given bail.

3. No invigilator who allows malpractice in examination is strict.
   Some teachers are invigilators who allow malpractice in examination.
   Therefore, some teachers are not strict.

4. All logicians are vegetarians.
   Raghu is a logician.
   Therefore, Raghu is a vegetarian.

5. All cats are mammals
   All mammals are vertebrates.
   Therefore, all cats are vertebrates.

6. All humans are bipeds.
   Tigers are not humans.
   Therefore, tigers are not bipeds.

7. All tutors are teachers.
   Some students are tutors.
   Therefore, some students are teachers.

8. Some amphibians are egg-laying animals.
   Some reptiles are amphibians.
   Therefore, some reptiles are egg-laying animals.

9. All reptiles are vertebrates.
   All crocodiles are vertebrates.
   Therefore, all crocodiles are reptiles.

10. No snakes are quadrupeds.
    No snakes are bipeds.
    Therefore, no bipeds are quadrupeds.

11. Some Labradors are not white.
    No Alsatians are Labradors.
    Therefore, Alsatians are not white

12. All insurable items are valuable items.
    No black-and-white TV is a valuable item.
    Therefore, no black-and-white TV is an insurable item.
13. All A is B.
    Some C is B.
    So, some C is A
14. No A is B.
    Some C is B.
    So, some C is not A.

IV. Test the validity of the above syllogistic arguments (given in question III, 1 - 14) by using Venn diagram.

V. Point out in each case the mood and figure of the argument and say whether it is valid or invalid.

1. All P is M.
   No S is M
   No S is P.
2. No P is M.
   Some M is S.
   Some S is not P.
3. Some P is M.
   No M is S.
   Some S is P.
4. All P is M.
   Some S is not M.
   Some S is not P.
5. Some M is not P.
   No M is S.
   Some S is not P.

6. No P is M.
   All S is M.
   No S is P.
7. Some M is not P.
   All M is S.
   No S is P.
8. No P is M.
   Some M is S.
   All S is P.
9. All M is P.
   Some M is S.
   Some S is P.
10. Some M is P.
    All S is M.
    No S is P.
11. All P is M.
    Some S is not M.
    Some S is not P.
12. No P is M.
    All M is S.
    No S is P.
13. All M is P.
    All S is M.
    All S is P.
14. No P is M.
    All S is M.
    No S is P.
15. Some M is not P.
    No M is S.
    Some S is P.

Essay Type Questions

1. What is a categorical syllogism? Explain its structure and constituent parts.
2. What is meant by figure of a syllogism? How is it determined ? Explain.
3. State and explain the *dictum de omni et nullo*.
4. State and explain the rules of categorical syllogism.
5. Explain the function of middle term in a syllogism. Explain why it should be distributed at least once.
6. Prove the following :
   (a) The minor premise must be affirmative in the first figure.
   (b) If the conclusion is an A-proposition then the syllogism must be in the first figure.
   (c) In the second figure the major premise must be universal.
   (d) In the third figure the conclusion must be particular.
7. What is meant by reduction? Reduce CESARE both directly and indirectly.
8. What is indirect reduction? Reduce BAROCO indirectly?

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CHAPTER - 3
MIXED SYLLOGISM

3.1 Different Forms of Mixed Syllogism :

A syllogism is a form of mediate inference in which a conclusion is drawn from the joint assertion of two premises. In a syllogism, when both the premises and the conclusion are categorical propositions, it is called pure-categorical syllogism. In the like manner, a syllogism is a pure-hypothetical syllogism when all its constituent propositions are hypothetical propositions. Pure-alternative and pure-disjunctive syllogisms are not in general valid arguments.

In a syllogism, when all the constituent propositions are not of one kind, we call it a mixed syllogism. In a mixed-syllogism the constituent propositions are not of one particular type. There can be four different types of mixed syllogism like (1) Hypothetical-Categorical, (2) Disjunctive-Categorical, (3) Alternative-Categorical syllogisms, and (4) Dilemma.

3.2 Hypothetical-Categorical Syllogism :

This is a kind of mixed syllogism in which the major premise is a hypothetical proposition, the minor premise is a categorical proposition and the conclusion is a categorical proposition. Symbolically it is represented as,

If A is B then C is D.
A is B.

Therefore, C is D.

A concrete example is as follows :

If it rains, then the ground will be wet.
It has rained.

Therefore, the ground is wet.

In a mixed hypothetical-categorical syllogism, the major premise is a hypothetical proposition having two parts - the antecedent and the consequent. In the example cited above, "it rains" is the antecedent and "the ground will be wet" is the consequent. The antecedent states a sufficient condition for the truth of the consequent and the consequent states a necessary condition for the truth of the antecedent. In the minor premise, either we affirm the antecedent or deny the consequent. Accordingly, in the conclusion, either we affirm the consequent or deny the antecedent. There are two valid forms of mixed hypothetical syllogism (1) Constructive Hypothetical-Categorical and (2) Destructive Hypothetical-Categorical.

(1) Constructive Hypothetical-Categorical Syllogism: Constructive hypothetical syllogism is otherwise called as *Modus Ponendo Ponens*. It states that by affirming the antecedent, we can affirm the consequent. Consider the following hypothetical-categorical syllogism.

If Asok is in Bhubaneswar, then he is in Odisha.
Asok is in Bhubaneswar.

Therefore, Asok is in Odisha.

In the major premise the antecedent. "Asok is in Bhubaneswar" states a sufficient condition for the truth of the consequent "Asok is in Odisha". Since the antecedent states the sufficient condition for the truth of the consequent, by affirming the antecedent we may validly derive the conclusion which affirms the consequent of the major premise.

But we cannot argue in the reverse order. In other words, by affirming the consequent in the minor premise we cannot affirm the antecedent in the conclusion. If we affirm the antecedent by affirming the consequent the argument will be fallacious. It will be a fallacious application of Modus Ponens. Consider the following example,

If Asok is in Bhubaneswar, then he is in Odisha.
Asok is in Odisha.
Therefore, Asok is in Bhubaneswar.

This argument is invalid because it is possible for both the premises to be true and yet the conclusion to be false. By affirming the consequent of the major premise in the minor

premise we cannot affirm the antecedent of the major premise in the conclusion. This is a fallacious form of *Modus Ponens*. By affirming the consequent we cannot affirm the antecedent. So the rule of validityof the constructive form of hypothetical-categorical syllogism may be stated as follows :

By affirming the antecedent we affirm the consequent, but not conversely. Violation of this rule leads to the fallacy of affirming the consequent.

(2) Destructive Hypothetical-Categorical Syllogism: The second form of the hypothetical-categorical syllogism is called Destructive Hypothetical-Categorical syllogism. It is otherwise called *Modus Tollendo Tollens*. The rule concerning *Modus Tollens* states that *by denying the consequent, we deny the antecedent*. Consider the following argument.

If Asok is in Bhubaneswar, then he is in Odisha.
Asok is not in Odisha

Therefore, Asok is not in Bhubaneswar.

Here the major premise is a hypothetical proposition, the minor premise denies the consequent of the major premise and the conclusion denies the antecedent of the major premise. An argument of this form is valid because the consequent of a hypothetical proposition states a necessary condition for the truth of the antecedent. Since we deny the consequent in the minor premise, we can deny the truth of antecedent of the major premise in the conclusion.

But the reverse is fallacious. By denying the antecedent, if we deny the consequent, we shall commit the *fallacy of denying the antecedent*. If we proceed by denying the antecedent in the minor premise, the argument in question will be invalid. To illustrate this, let us consider the following argument.

If Gita is a mother, then she is a woman,
Gita is not a mother.

Therefore, Gita is not a women.

This argument is obviously invalid because Gita can still be a woman even if she is not a mother. Here we commit the *fallacy of denying the antecedent*.

3.3 Disjunctive-Categorical Syllogism :

This is a kind of mixed syllogism in which the major premise is a disjunctive proposition, whereas the minor premise and the conclusion are categorical propositions. A disjunctive proposition consists of two component propositions, which are called its disjuncts. A disjunctive proposition is of the form "Either A is B or C is D" in which "either... or ..." is understood in the inclusive sense. A disjunctive proposition asserts that at least one of the disjuncts is true. It allows for the possibility that both disjuncts may be true.

In a disjunctive-categorical syllogism the major premise is a disjunctive proposition. The minor premise denies one of the two disjuncts of the major premise. From these two premises we draw the conclusion that the other disjunct of the major premise is true. Consider the following argument forms.

Either A is B or C is D.	OR	Either A is B or C is D
A is not B.		C is not D
Therefore, C is D.		Therefore ,A is B

The following is a concrete example of disjunctive-categorical syllogism.

Either Rabi is telling the truth or Asok is innocent.
Rabi is not telling the truth.
Therefore, Asok is innocent.

This argument is valid. The form of this argument is *Modus Tollendo Ponens*, which means by denying one alternative we can affirm the other. In other words, the falsity of one of the alternatives implies the truth of the other. However, by affirming one we cannot deny the other alternative. For example, the following argument will be invalid.

Either students are intelligent or they are laborious.
The students are intelligent .

Therefore, students are not laborious.

Such a conclusion is obviously fallacious, since the major premise allows for the possibility that students can be both intillgent and laborious.

3.4 Alternative-Categorical Syllogism :

This is a kind of mixed syllogism in which the major premise is an alternative proposition and the minor premise is a categorical proposition affirming one of the alternaitves of the major premise. The conclusion is a categorical proposition that denies the other alternative. It is also expresed in the exclusive of either .... or.

X can't be both Y and Z.		X cannot be both Y and Z
X is y	OR	X is Z
Therefore, X is not Z.		∴ X is not Y

Rakesh cannot be born in both January and May.
Rakesh is born in January.

Therefore, Rakesh is not born in May.

This is a valid form of syllogism called *Modus Ponendo Tollens*. But the other form is invalid which is evident from the following example.

A is not both P and Q.
A is not P.
Therefore, A is Q.

or

Ashok is not both in Delhi and Lucknow.
Ashok is not in Delhi.
Therefore, Ashok is in Lucknow.

This form of alternative-categorical syllogism is invalid as its premises can both be true but the conclusion be false. It must be noted that alternative categorical syllogism is valid if we affirm one of the alternatives in the minor premise, we may deny the other in the conclusion but not conversely.

3.5 Dilemma :

Dilemma is a kind of mixed syllogism in which the major premise is a compound hypothetical proposition, the minor premise is a disjunctive proposition and the conclusion is either a categorical or a disjunctive proposition.

The dilemma is a combination of two hypothetical-categorical syllogisms. So, like mixed-hypothetical syllogism a dilemma has two forms (i) Constructive Dilemma and (ii) Destructive Dilemma. Furthermore, a dilemma is known to be simple, if the conclusion is a categorical proposition and it is called complex, if the conclusion is a disjunctive proposition. Thus we get four types of dilemma viz. (i) Simple constructive, (ii) Simple destructive, (iii) Complex constructive and (iv) Complex destructive.

i) **SIMPLE CONSTRUCTIVE DILEMMA:** It is a kind of mixed syllogism in which the major premise is a compound-hypothetical proposition, (i.e. a conjunction of two hypothetical propositions), and the minor premise is a disjunctive proposition in which the antecedents of the major premise are affirmed disjunctively, and the conclusion is a categorical proposition. Symbolically it is of the following form :

If A is B, C is D and if E is F, C is D
Either A is B or E is F

Therefore, C is D

Example:

If a person arranges a grand marriage reception, he is subject to criticism and if he arranges a modest reception, he is also subject to criticism.
Either the a person will arrange a grand reception or a modest reception.

Therefore, in any case, he is subject to criticism

ii) **SIMPLE DESTRUCTIVE DILEMMA :** In a simple destructive dilemmatic argument the consequents of the compound hypothetical major are alternatively denied in the minor premise and the conclusion is a categorical proposition. In other words, it is a kind of mixed syllogism in which the major premise is a compound hypothetical proposition and the minor premise is a disjunctive proposition in which the consequents of the major premise are alternatively denied. Finally, the conclusion is a denial of a categorical proposition. Symbolically it is of following form :

If A is B then C is D and if A is B then E is F
Either C is not D or E is not F

Therefore, A is not B

Concrete example :

If Hari has to achieve success, then he must toil hard and if he has to achieve success, he must be fortunate.
Either Hari does not toil hard or he is not fortunate

Therefore, Hari will not achieve success.

iii) **COMPLEX CONSTRUCTIVE DILEMMA:** Complex constructive dilemma is an argument, where the major premise is a compound hypothetical, in the minor premise the antecedents of the major premise are disjunctively affirmed and the conclusion is a disjunctive proposition. It is of the following form :

If A is B then C is D and if E is F then G is H
Either A is B or E is F

Therefore, either C is D or G is H

Concrete example :

If Rakesh is in Cuttack, he is in Odisha and if he is in Kolkata, then he is in Bengal
Rakesh is either in Cuttack or in Kolkata

Therefore, he is either in Odisha or in Bengal.

iv) **COMPLEX DESTRUCTIVE DILEMMA :** In this kind of dilemma, the major premise is a compound-hypothetical proposition, the minor premise and the conclusion are disjunctive propositions. Moreover, in the minor premise, the consequents of the major premise are disjunctively denied.

It is of the following symbolic form :

If A is B then C is D, and if E is F then G is H.
Either C is not D or G is not H.

Therefore, either A is not B or E is not F.

Concrete example :

If Rakesh is in Cuttack, then he is in Odisha and if he is in Kolkota, then he is Bengal.
Either he is not in Odisha or he is not in Kolkota.

Therefore, either Rakesh is not in Cuttack or he is not in Kolkota.

REFUTATION OF DILEMMA:- Normally, the formal validity of dilemmatic argument is not in question. Since a dilemma is a complex form of hypothetical-categorical syllogism, no new principles are involved in determining the formal validity of dilemmatic arguments. If one is in doubt regarding the validity of a dilemmatic argument, then the argument can be analysed into its constituent hypothetical-categorical syllogism to check whether the rules have been obeyed or not.

But in most cases, dilemmatic arguments are based on assumptions which are not correct. There are mainly three ways of evading the conclusion of a dilemma. These three ways have been given special names. These are

a) Escaping between the horns

b) Taking the dilemma by the horns

c) Rebutting the dilemma by a counter dilemma.

(a) Escaping between the horns:- In this method, one refutes a given dilemma by showing that the alternatives given in the minor premise are not exhaustive and there is a third alternative which goes in favour of the opponent. Let us take the example of the dilemma presented by an Athenian mother to restrain her son from going outside the house in the following manner.

If the day is hot, you should not go out to avoid exhaustion and if the day is cold, you should not go out to avoid exposure to cold. Either the day is hot or cold. Therefore, you should not go outside to avoid exhaustion or exposure.

The son could escape between the horns by showing a third possibility. Since some parts of the day are neither hot nor cold and during that period he could go out, which will not be harmful for his health.

(b) Taking by the horns:- Here we may point out that either one consequent or both consequents do not follow from their antecedents. Thus the dilemma is wrong and the conclusion cannot be established. Let us examine a simple constructive dilemma.

If the son is efficient, then the father's saving is unnecessary and if the son is misfit, then the father's saving is unnecessary. Either the son is efficient or is a misfit. Therefore, in any case the father's saving is unnecessary.

In the above dilemma, both the alternatives in the major premise are weak. There is no justification in comparing the father's saving with the efficiency or misfitness of the son. Furthermore, it is not justified to say that father's saving is only meant for son's benefit. Thus both the horns of the dilemma are weak and it will be easier to take the dilemma by horns.

(c) Rebutting a dilemma by a counter dilemma: It is one of the most ingenious method by which a dilemma can be rebutted by constructing another counter dilemma whose conclusion is opposed to the original conclusion. Let us take a classical example of an Athenian mother persuading her son not to join politics in the following manner.

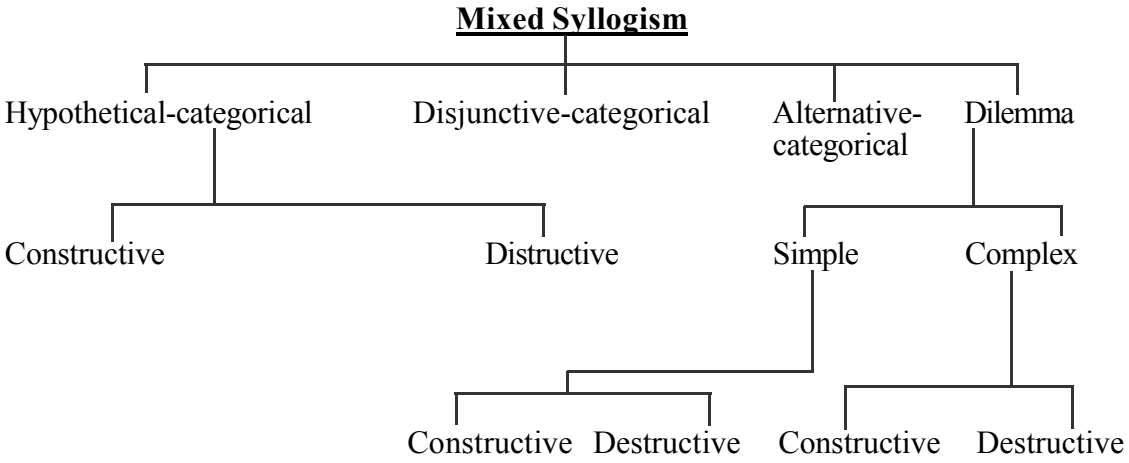
If you say what is just, men will hate you and if you say what is unjust, Gods will hate you. But you must either say the one or the other. Therefore, you will be hated.

The son rebutted the dilemma in the following manner :

If I say what is just, the Gods will love me and if I say what is unjust, men will love me. I must say either the one or the other. Therefore, I shall be loved.

The conclusion of the first dilemma(by the mother) is changed in the conclusion of the rebutted dilemma.

For convenience we may restate kinds of mixed syllogism in a tabular from as given below :



SUMMARY

In this chapter we explain and illustrate different kinds of mixed syllogism. A mixed syllogism is a syllogism where the constituent propositions are of different types. Accordingly, there are four types mixed syllogisms namely (1) Hypothetical-categorical, (2) Disjunctive-categorical, (3) Alternative-categorical and (4) Dilemma. Hypothetical-categorical syllogism is a mixed syllogism in which the major premise is a hypothetical proposition, the minor premise as well as the conclusion are categorical propositions. It admits two valid forms such as of (i) Constructive hypothetical-categorical syllogism and (ii) Destructive hypothetical syllogism. The former case is based on the principle that by affirming the antecedent of hypothetical, we affirm its consequent; where as the latter is based on the principle that by denying the consequent of a hypothetical, we deny its antecedent. Two fallacies are involved in hypothetical-categorical type of mixed syllogism. These are the fallacy of affirming the consequent and the fallacy of denying the antecedent. Another type of mixed syllogism is disjunctive-categorical syllogism. It is a mixed syllogism where the major premise is a disjunctive proposition, the minor premise is a categorical proposition and the conclusion is a categorical proposition. It is based on the principal that by denying one of the disjuncts we affirm the other disjunct. This form of argument is otherwise called *modus tollendo ponens*.

It admits of one fallacious form. The fallacy occurs if we infer one of the disjuncts by affirming the other. Similarly, alternative-categorical syllogism is a mixed syllogism where the major premise is an alternative proposition, the minor premise is a categorical proposition and the conclusion is a categorical proposition. Finally, dilemma is a kind of mixed syllogism where the major premise is a compound hypothetical proposition, the minor premise is a disjunctive proposition and the conclusion is either a categorical proposition or a disjunctive proposition. Dilemma may be simple or complex. This classification is dependent upon the nature of the conclusion. If the conclusion of the dilemma is a categorical or denial of a categorical proposition the dilemma is simple. If the conclusion of a dilemmatic argument is of disjunctive form then it is called complex. Each of the form admits two sub-forms constructive and destructive. Accordingly we have four forms of dilemmatic argument namely (i) Simple constructive, (ii) Simple destructive, (iii) Complex constructive and (iv) Complex destructive dilemma.

MODEL QUESTIONS

Objective type questions :

I. Point out in each case whether the statement is true or false :

1) In a dilemma the minor premise must be disjunctive.
2) Hypothetical-categorical syllogism is a form of mixed syllogism.
3) Modus ponens states that by affirming the antecedent, we affirm the consequent.
4) Modus tollendo tollens states that by denying the antecedent we deny the consequent.
5) The fallacy of denying the antecedent occurs, if by denying the consequent, we deny the antecedent.
6) Disjunctive-categorical. syllogism is a mixed syllogism in which the conclusion is a disjunctive proposition.
7) Disjunctive-categorical syllogism is based on the principle that by denying one of the disjuncts we affirm the other.

8) Alternative-categorical syllogism is a mixed syllogism in which the major premise is an alternative proposition and the minor premise is a categorical proposition.

9) Dilemma is a mixed syllogism in which the major premise is a compound hypothetical proposition.

10) If A is B, C is D and if E is F, C is D.
Either A is B or E is F.
∴ C is D

This is an example of simple constructive dilemma.

II. Match the following :

1)	If A is B then C is D Infact A is B ∴ C is D	(a) The fallacy of affirming the consequent
2)	If A is B then C is D C is not D ∴ A is not B	(b) The fallacy of denying the antecedent
3)	If A is B then C is D A is not B ∴ C is not D	(c) Modus ponens
4)	If A is B then C is D C is D ∴ A is B	(d) Modus tollendo tollens

III. Answer the following questions by choosing the correct option.

1. Which of the following is a valid form of hypothetical-cateogircal syllogism.

a) If A is B then C is D.
A is not B
∴ C is not D

b) If A is B then C is D.
If C is D then E is F.
∴ If A is B then E is E.

c) If A is B then C is D.
C is D
∴ A is B

d) If A is B then C is D.
A is B
∴ C is D

2. Which of the following is a case of the fallacy of denying the antecedent.

a) If A is B then C is D.
A is not B
∴ C is not D

b) If A is B then C is D.
A is not B
∴ C is D

c) If A is not B then C is not D.
A is not B.
∴ C is not D

d) None of the above.

3. Which of the following is true of simple constructive dilemma.

a) Simple constructive dilemma is a kind of mixed syllogism where the major premise is a simple proposition.

b) Simple Constructive dilemma is a kind of dilemma, where the conclusion is a disconjuctive proposition.

c) Simple constructive dilemma is a kind of dilemma where the minor premise is a disjunctive propsotion.

d) None of the above.

4. Which of the following is an example of complex constructive dilemma.

a) If you act impartially men will hate you and if you act partially God will hate you. Either you will act impartially or partially. Therefore, in any case you will be hated either by men or by God.

b) If A is B then C is D and if A is B then E is F. Either C is not D or E is not F. Therefore, in any case A is not B.

c) If A is B then C is D and if E is F then G is H. Either C is not D or G is not H. Therefore in any case either A is not B or E is not F.

d) None of the above.

5. Modus Ponens asserts which of the following :

a) By affirming the antecedent, we affirm the consequent.

b) By affirming the antecedent, we deny the consequent.

c) By denying the consequent, we deny the antecedent.

d) None of the above.

6. Modus tollens asserts which of the following :

a) By affirming the consequent, we deny the antecedent.

b) By denying the consequent, we deny the antecedent.

c) By denying the antecedent, we deny the consequent.

d) None of the above.

7. State the appropriate reason : A dilemma is called simple because :

a) The major premise is a simple proposition.

b) The conclusion is a categorical proposition.

c) In the minor premise we deny the consequent.

d) None of the above.

8. If A is B then C is D and if A is B then E is F. Either C is not D or E is not F. Therefore, A is not B.

The form of the above dilemma is

a) Simple Constructive.

b) Simple Destructive.

c) Complex Constructive.

d) Complex Destructive.

Essay Type Questions

1. What is meant by mixed syllogism? Explain its different forms with examples.
2. Explain and illustrate hypothetical-categorical syllogism. Discuss the fallacies relating to this form of mixed syllogism.
3. Distinguish between disjunctive-categorical syllogism and alternative-categorical syllogism. Explain the fallacies committed with each of these forms of mixed syllogism.
4. Explain the nature of dilemmatic argument. How is a dilemma rebutted? Explain with examples.
5. Explain with examples different form of dilemma.
6. What is a dilemma? Explain different ways of evaluating the conclusion of a dilemma.
7. Explain with examples the method of rebutting a dilemma by a counter dilemma.
8. Write notes on :
   (i) Disjunctive-Categorical Syllogism.
   (ii) Fallacy of denying the antecedent.
   (iii) Constructive hypothetical categorical syllogism.
   (iv) Simple constructive dilemma.
   (v) Refutation of dilemma.

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CHAPTER - 4

PROPOSITIONAL LOGIC

Propositional logic, is an indispensible part of symbolic logic. It deals with the following basic notions. These are 'propositional variable', 'propositional connective', 'parenthesis', 'truth values', 'truth function', 'truth table', and 'tautology'.

4.1 Basic Concepts of Propositional Logic :

(a) Propositional variable :

The notion of variable in general is essential for the development of logic and mathematics. In the field of logic it was introduced, for the first time, by Aristotle. It is important at least for two reasons. Firstly, the variables are used in logic and mathematics to express a complicated thought in a simple and exact manner. For example, the thought expressed by the equation "$(a+b)^2 = a^2 + 2ab + b^2$" would become unnecessarily cumbersome if expressed by the ordinary language. The precision, exactness and simplicity of a logical thought is achieved if the thought is expressed by symbolic notation. This is so because of the abstract nature of logical and mathematical ideas. The above equation in, addition to other kinds of symbols, contains two variable symbols namely 'a' and 'b'. As a result, it becomes so precise and simple that even a school boy can understand it. Secondly, the variables are required to express generality. Since the principles of logic are highly general, they necessarily require the notion of variable. In propositional logic we use one type of variable symbol called propositional variable. We use lower case English letters with or without subscripts as propositional variable symbols. For example, p, q, r, s or p_1, p_2, p_3, q_1, q_2.... are used as propositonal variable symbols. They are called so because they designate only propositions. (Even if in practice we do not require an infinite number of popositional variables, yet for theoretical reasons, we take the set of propositional variable symbols to be infinite. This requirement is theoretically essential, because otherwise we may face

shortage of variables, while translating an argument). Further, we use capital English letters such as P, Q, R, S as metavariables for propositional variables. These are required to talk or make a statement about propositional variable in general. (Briefly, a symbol is called a propositional variable symbol if and only if propositions are used as its only value and nothing else. In other words, propositional variable symbols stand only for propositions).

(b) Propositional Connectives Symbols :

In addition to propositional variables, propositional logic contains another type of symbol called the logical connectives symbol. There are five basic connectives accepted in propositional logic whose function is to form compound propositions out of simple propositions. They are known as 'negation', 'conjunction', 'disjunction', 'implication (conditional)', and 'equivalence (or biconditional)'. The usual word or phrase respectively stand for them are 'not', 'and', 'either… or…', 'if ….then…', and '…if and only if…'. We use the symbol '~' (curl) for 'not'; '.' (dot) for 'and'; 'vel' 'v' (wedge) for 'either… or …'; '⊃' (horse shoe) for 'if …then…'; and '≡' (triple bar) for … if and only if…' The intuitive and precise sense of each of the connective will be discussed below.

Negation :

The symbol '~' denotes negation. We read it as 'curl' or 'tilde'. It is one of the basic or fundamental connectives of propositional logic and is used in denying a proposition. To obtain a denial of a proposition in logic it is customary to place the negative particle "it is not the case" (or in symbol '~') before the whole proposition. For example, the denial of the propostion 'Ram is rich' is "It is not the case that Ram is rich". Symbolically if p stands for the proposition "Ram is rich" then its negation '~ p' would stand for " Ram is not Rich".

Consider a proposition, "Ram is not honest". Clearly this proposition is a denial of the proposition 'Ram is honest'. Thus, the proposition "Ram is not honest" is of the form "It is not the case that Ram is honest". Symbolically it would be expressed as '~ p', where 'p' stands for "Ram is honest". Hence '~ p' is obtained from 'p' by use of the connective '~'. This means '~' is a uninary connective as it operates on a single proposition. The negation of p is otherwise known as contradictory of p.

When we assert a proposition p, the intended meaning is that p is true. Similarly, if we assert '~ p' then the intention is to say that p is false. Thus, 'truth' and 'falsehood' are called

values of propositions. We use 'T' and 'F' to designate truth and falsehood respectively. Thus, 'T' and 'F' are the two truth values of propositions. In propositional logic we have only these two truth values. Note that 'T' and 'F' are opposed to each other. In other words, if a proposition is true then its negation would be false and conversely. The negation of a true proposition is false and the negation of a false proposition is true. For any propositional variable p, the truth table for ~ p is as follows.

P	~ P
T	F
F	T

Truth Table for Negation

Consider the proposition '~ p'. Clearly '~ p' is itself a proposition containing another proposition 'p' as its part. Hence, we may call '~ p' a compound proposition. On the other hand, 'p' contains no other propositions as its part. Hence, 'p' is called simple or atomic proposition. Alternatively, a proposition is called simple or atomic if it contains no connective, whereas any complex proposition contains at least one connective. Clearly '~ p', '~ ~ p', '~ ~ ~ p' are all complex propositions, whereas 'p' is an atomic proposition.

The above truth table for negation shows that it is a truth functional connective. Because the truth value of '~ p' is uniquely determined from the value of 'p'. This means, if p is true then the truth value of '~ p' is false. Similarly if p is false the value of '~ p' is true. Hence given the value of p, the truth value of '~ p' is uniquely determined.

Conjunction :

Conjunction is another basic logical connective of propositional logic. It is used to construct conjunctive propositions. For example, given the propositons "Ram is a boy" and "Sita is a girl", we construct a conjunctive proposition "Ram is a boy and Sita is a girl" by joining these two propositions by means of the connective 'and'. In logic we use the symbol '.' (dot) to denote conjunction. If 'p' stands for the proposition "Ram is a boy" and 'q' stands for the proposition "Sita is a girl" then the conjunctive proposition "Ram is a boy and Sita is a girl" is symbolised as (p . q). The constituent propositions of a conjunctive proposition are called conjuncts. For example, in (p . q), 'p' and 'q' are both conjuncts. Conjunction is a binary connective, because to form a

conjunctive proposition we need at least two propositions (not necessarily distinct). In accordance with the meaning of a conjunctive proposition in our ordinary language we say that a conjunctive proposition is true if and only if both of its conjuncts are true and is false otherwise. For example, the proposition "Hari and Govinda are tall" would be true if "Hari is tall" is true and "Govinda is tall" is true. Otherwise, the proposition "Hari and Govinda are tall" would be false. This means the above conjunctive proposition is false if at least one of its conjuncts is false. Let 'p' denote "Hari is tall" and 'q' denote "Govinda is tall", then clearly "Hari is tall and Govinda is tall" is symbolised as (p . q). Since every proposition, by definition, is eitehr true or false but not both, we have in this case four mutually exclusive and collectively exhaustive truth value distribution with respect to 'p' and 'q'. These are shown as follows

(1) p is true q is true
(2) p is true q is false
(3) p is false q is true
(4) p is false q is false

In accordance with the meaning of 'and' in our ordinary language we say that in first case given above the truth value of (p . q) is T or true whereas in cases from (2) - (4) the truth value of (p . q) is F or false . The systematic truth value assignments of (p . q) (where p and q stand for any proposition) may be exhibitted in a tabular form given below:

P	q	(p . q)
T	T	T
T	F	F
F	T	F
F	F	F

The Truth Table for Conjunction

A conjunctive proposition (p . q) is true if both of its conjuncts, namely 'p' and 'q', are true and (p . q) is false if at least one of its conjuncts is false.

The conjunction is a truth functional connective like that of negation. Because the truth value of any conjunctive proposition is uniquely determined by the truth value of its component

atomic propositions. For example, the truth-value of 'p' and 'q' uniquely detrmines the truth value of (p . q).

In English language the word 'and' is used to form a conjunction. However, words like 'but', 'yet', 'also', 'still', 'although', 'however', 'moreover', never the less', 'as well', 'as well as' and even the punctuation symbol like comma '**,**' and the semicolon '**;**' are sometimes used to form conjunction of two propositions.

In order to form a conjunctive proposition in logic it is not necessary that both the conjuncts are related in content. Since conjunction is a truth functional connective, we may conjoin any proposition with any other proposition. For example, given two unrelated propositions say "2+2=4" and "Ram is a student", we can form their conjunction as "2+2=4 and Ram is a student". It is perfectly in order in propositional logic.

Disjunction :

Like conjunction, disjunction is a binary connective. To form a disjunctive proposition we need at least two (not necessarily distinct) propositions. For example, given the proposition "Hari is tall" and "Govinda is tall", a disjunctive proposition "Either Hari is tall or Govinda is tall" is formed by use of the phrase "either **...** or **...** " or simply "or". We use the symbol 'v' to express disjunction. Let 'p' denote "Hari is tall" and 'q' denote "Govinda is tall". Then the disjunctive proposition, "Either Hari is tall or Govinda is tall" is symbolised as (p v q). We read the proposition "(p v q)" as "either p or q", or simply "p or q". The constituent propositions in a disjunction are called disjuncts. In the above case, 'p' and 'q' are disjuncts. The phrase 'either **...** or **...'** or the word 'or' is used in our language in two senses, namely inclusive sense and exclusive sense. Let us illustrate these two senses of 'either... or...'. Suppose a salesman requests a customer to buy an almirah or a bookshelf. To understnd the sense of 'or' in this request let us examine under what conditions the request would be satisfied and under what conditions the request would not be satisfied. In this case we have two disjuncts namely, "The customer agrees to buy an almirah" and "The customer agrees to buy a bookshelf". So far as its truth value distribution is concerned we have four possible cases in all. These are (1) the customer agrees to buy both; (2) the customer agrees to buy an almirah but not a bookshelf; (3) the customer agrees to buy a bookshelf but not an almirah; and finally (4) the customer does not agree to buy any of the two. Clearly the request is not kept in case 4. This means a disjunctive proposition is false if both of its disjuncts

are false. If (2) or (3) holds the request is satisfied. The sales person would be happy if the customer agrees to buy both. From cases (2) and (3), we notice that a disjunctive proposition would be true if at least one of its disjuncts is true. So also case (1) would be true because in this case both the disjunctis are true. This is the disjunction in the inclusive sense because it is true even if both of its disjuncts are true. For example, let 'p' stand for Mr. X buys an almirah and 'q' stand for 'Mr. X buys a bookshelf", then "Either Mr. X buys an almirah or a bookshelf" would be symbolised as (p v q). The truth table for disjunction in the inclusive sense would be as follows :

P	q	(p v q)
T	T	T
T	F	T
F	T	T
F	F	F

Truth table for disjunction (inclusive sense)

In addition to the inclusive sense there is another sense of 'either **...** or **...**' called the exclusive sense. Consider the following situation. A father asks his child to choose to take admission either in Central school or in DAV school. Here what the father means is that the child is to choose one of the schools but not both. Similarly, if you are asked to cast your vote for Mr. X or Mr. Y, you are required to vote either for Mr. X or for Mr. Y and not for both. Casting your vote for both would make your vote invalid. In other words, a disjunctive proposition in this sense would be false if both of its disjuncts are true. Similarly, the disjunction will not also hold good if the child chooses neither Central School nor DAV School. This implies that a disjunctive proposition in the exclusive sense is false if both the disjuncts are false or both of them are true. The disjunction would be true if exactly one of the disjuncts holds good.

Let p stand for the child will choose to take admission in the Central School, 'q' stand for the child will choose to take admission in DAV School" and let the symbol '$\wedge$' denote "either... or..." in the exlcusive sense. Then the proposition "Either the child will choose to take admission in the Central school or in DAV School" is symbolised as "$p \wedge q$". The truth table for '$\wedge$' would be as follows:

P	q	(p ∧ q)
T	T	F
T	F	T
F	T	T
F	F	F

Truth table for atternation

Some logicians call disjunction in exclusive sense as 'alternation'. Thus '∧' may be read as alternative truth function and the proposition, where '∧' is the main connective, is called alternative proposition.

However, '∧' is not an independent connective. Because, the truth table for 'p ∧ q' is the same as that of '(p v q) . (~ p v ~ q)'. Since we have 'v' and '~' as basic connectives and we can define '∧' in term of '~' and 'v', it is not necessary to treat '∧' as a basic truth funtional connective.

Note that disjunction is a truth functional connective, because the truth value of any disjunctive proposition is uniquely determined by the truth value of its atomic propositions.

The word 'unless' is also used to express a disjunctive proposition. For example, "Your performance will be poor in the examination unless you are regular in the class' may be symbolized as 'p v q' where 'p' denotes "your performance in the examination will be poor" and 'q' denotes "you are regular in class". This is so because we use the word unless to mean if one of the proposition is not true the other must be true. Accordingly the above proposition would mean that if you are not regular in the class then your performance will be poor in the examination. This is the sense of disjunction as it asserts that one of the disjuncts is true.

Implication :

We use the phrase "if **...** then **...**" to obtain from two propositions (not necessarily distinct) a conditional proposition. A conditional proposition is otherwise known as implicative proposition. For example, let "Ram is telling truth" and "Hari is innocent" be two given propositions. The conditional proposition "If Ram is telling the truth then Hari is innocent" is formed out of two given propositions "Ram is telling the truth" and "Hari is innocent" by using the phrase "if...then". From any two propositions p and q (not necessarily distinct), we can form a conditional

proposition ($p \supset q$). The symbol '$\supset$' stands for implication. We read '($p \supset q$)' as 'if p then q'. In an implicative proposition, the proposition immediately following 'if' is called the 'antecedent' and the proposition immediately following "then" is called the "consequent". An antecedent is otherwise known as 'if - clause' and the consequent is called 'then - clause'. For example, in '($p \supset q$)' is 'p' the antecedent and 'q' is the consequent.

There are several idioms in English which express implication. For example, the expressions 'p implies q', 'p only if q', 'q if p', 'q provided that p', 'p is a sufficient condition for q' or 'q is a necessary condition for p' can be symbolically expressed as ($p \supset q$).

To get the truth conditions for implication, let us consider the following implicative proposition and check the conditions under which it is true or false. Consider the following promise by a father to his daughter. "If you do well in the examination, I will buy a scooter for you." Surely this will be true, if she does well in the examintaion and a scooter is bought for her. But suppose she does well in the exmaination but her father does not buy a scooter then clearly the promise is broken. Suppose she does not do well in the examination but the father buys a scooter for her. Then surely the commitment is not violated and hence the promise is not broken. The implication remains true. Finally, consider the situation : the daughter does not do well in the examination and the father does not buy her a scooter (i.e. both the antecedent and the consequent of the implicative proposition are false). In this case also the commitment is not violated and hence the implication remains true.

From the above considerations we have the following truth table for implicative proposition ($p \supset q$) where p and q stand for any atomic propositions.

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

Truth table for implication

This truth-table suggests that an implicative proposition is false if the intecedent is true and the consequent is false, otherwise the implication is true. In other words, an implication is true if the antecedent is false or the consequent is true.

Like that of conjunction and disjunction, implication is a binary connective needing at least two propositions for its application. In everyday language the phrase "if **...** then. **...**" is used in many senses. 'Implication' can be a causal implication or a strict implication (or modal implication) or a truth functional implication. In the present work we consider implication in the truth functional sense.

Implication '$\supset$' is a truth functional connective. Given the truth values of antecedent and consequent the truth value of any implicative proposition is uniquely determined. In other words, for any given truth value of antecedent and consequent, the implicative proposition takes one and only one truth value. For example, if p = T and q = F, the truth value of $(p \supset q)$ is F.

Equivalence :

Given any two propositions, (not necessarily distinct) we construct an equivalent or a biconditional proposition by use of the phrase "... if and only if ...". The symbol '$\equiv$' (triple bar) is used to express the connective "if and only if". We read "$(p \equiv q)$" as "p if and only if q". Wherever we assert a biconditional proposition of the form $(p \equiv q)$, it is meant that p and q have the same truth value. Similarly wherever we deny $(p \equiv q)$, it is meant that p and q admit different truth values. For any proposition p and q, the truth conditions for $(p \equiv q)$ may be expressed by means of the following truth table.

P	q	$(p \equiv q)$
T	T	T
T	F	F
F	T	F
F	F	T

Truth table for equivalence

It says taht a biconditional proposition $(p \equiv q)$ is true if the truth value of p is the same as that of q and it is false if the value of p is different from the value of q.

Biconditional or equivalence is a binary connective as it needs at least two propositons for its application.

Like the other connectives discussed earlier the biconditional is a truth functional connective. The truth value of a biconditional proposition is uniquely determined by the truth values of its atomic components.

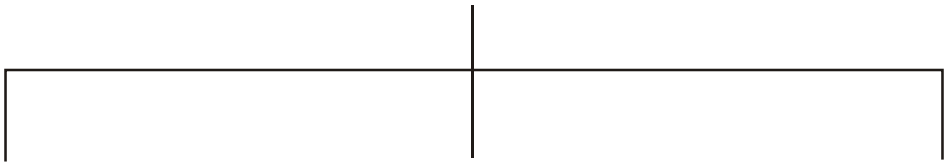
(c) Grouping Symbols : (Use of Brackets)

In addition to propositional variable symbols and connective symbols we also need grouping symbols such as '(' (left parenthesis) and ')' (right parenthesis) which we call brackets. Grouping symbols are necessary for propositional logic to express the form or structure of the complex propositions in an unambiguous manner. For example, without the use of grouping symbols the expression "$p \vee q \supset r$" becomes ambiguous. Because it may mean an implication between "$p \vee q$" and "r" or it may mean a disjunction of "p" and "$q \supset r$". Once grouping symbol such as '(' and ')' are available, we can express any proposition unambiguously. If we wish to use by the above expression "$p \vee q \supset r$" to mean $p \vee q$ implies r then we express this by use of grouping symbols as $((p \vee q) \supset r)$. Similarly if we wish to mean by the expression '$p \vee q \supset r$' as "either p or q implies r", we may express it by use of grouping symbols as $(p \vee (q \supset r))$.

In ordinary language, the proper grouping of various sentences or propositions are accomplished by a number of devices in order to form a complex sentence. In symbolizing such a sentence, these devices should be correctly translated by appropriate use of parentheses i.e.brackets. For example, consider the sentence (I) "If Ram wins the game then Hari and Sita will be dropped". It may be symbolized as $(r \supset (h \cdot s))$, where 'r' denotes, "Ram wins the game", 'h' denotes, "Hari will be dropped" and 's' denotes "Sita will be dropped". We read $(r \supset (h \cdot s))$ as, "If r then h and s". On the other hand, if (I) is symbolized or translated as $((r \supset h) \cdot s)$, we read it as, "Both, if r then h and s". This makes it clear that it is natural to symbolize (I) as $(r \supset (h \cdot s))$ rather than $((r \supset h) \cdot s)$. Thus without the use of grouping symbols, the unambiguous and exact readings of formulas would be either cumbersome or unintelligible or unnecessarily mind taxing.

For our convenience we may give the following classification of the basic categories of symbols necessary for propositional logic.

Symbols of propositional logic



Infinitely many Propositional variable symbols	Five Propositional connective symbols	Two Grouping symbols
{p, q, r,….}	{~, •, ∨, ⊃,≡ }	{(,)}

4.2 Formulas of Propostional Logic :

Now way proceed to define the notion of a formula, atomic and non-atomic formulas, sub-formula, proper sub-formula etc.

Def : Any finite sequence of symbol of propositional logic is called a formula if and only if it satisfies the following conditions.

(i) Any propositional variable standing alone is a formula. For example p,q,r, p_1, p_2, q_1, q_2... are formulas of propositional Logic.

(ii) If P is any formula then ~ P is also a formula. In other words, the negation of a formula is also a formula.

(iii) If P and Q are formulas then (P . Q), (p ∨ Q), (P ⊃ Q) and (P ≡ Q) are also formulas of propositional logic.

(iv) Nothing else is called a formula unless it satisfies the conditions (i)-(iii).

Def : A formula of propositional logic is called an atomic formula if and only if it contains no propositional conective symbols. Hence, only propositional variables like 'p', 'q', 'r'**...** are atomic formulas.

4.3 Translating Everyday Language :

As we have already discussed, the primary goal of logic is to test the validity or invalidity of arguments. Since validity depends on the form of argument and usually arguments are expressed in our ordinary language in which the form and content are intermixed, it is necessary to isolate or exhibit the form by suppressing the content. This is achieved by translating an argument into its symbolic form. To find the symbolic form of any sentence of our ordinary language, let us follow the following instructions. First, identify the number of distinct atomic sentences (i.e. a sentence

that contains no connective) that our given sentence contains. For example, consider the sentence "Ram is honest and Sita is not honest". This complex sentence clearly contains two atomic sentences namely "Ram is honest" and "Sita is honest". Similarly, consider the proposition "If Ram is a student then he is a student". Here there is only one atomic proposition "Ram is a student" occurring twice in the above sentence. In this way we first identify the number of distinct atomic sentences. Secondly we use distinct propositional variable symbols for the distinct atomic sentences. For example, since "Ram is honest" and Sita is honest" are distinct propositions let us use distinct propositional variables for them. So we use 'p' for "Ram is honest" and q for "Sita is honest". Then the sentence "Ram is honest and Sita is not honest" would be "p and not q". Thirdly, let us replace the connective word or words present in the original sentence by the appropriate connective symbols. In this way the original sentence "Ram is honest and Sita is not honest" would be translated as $(p \cdot \sim q)$. Of course we also use the appropriate number of grouping symbols to avoid ambiguity. Consider the following sentence :

"Either Rome is the capital of Italy or Rome is the capital of Spain."

Clearly this sentence contains two distinct atomic sentences, namely, "Rome is the capital of Italy" and "Rome is the capital of Spain". Let us use distinct propositional variables for these atomic sentences. Hence, we use 'p' for "Rome is the capital of Italy" and 'q' for "Rome is the capital of Spain". And we know that 'v' is the connective symbol for "either ... or ..." Taking all these into consideration we translate the sentence "Either Rome is the capital of Italy or Rome is the capital of spain" as "$(p \vee q)$". By following the same instructions we may translate any argument expressed in our ordinary language. For example, consider the following argument.

If Ram was selected for the post then he went to Delhi . If he went to Delhi then he joined the post there. Infact, Ram was selected for the post. Therefore, he joined the post.

Clearly this argument contians three district atomic sentences such as "Ram was selected for the post", "Ram went to Delhi", "Ram joined the post". We replaced each of these atomic sentences by district propositional variable as shown below.

Let p be "Ram was selected for the post."

q be "Ram went to Delhi."

and r be "Ram joined the post."

By using appropriate connective symbols and grouping symbols we translate the above argument into its symbolic form as follows

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

By following the instruction as explained above we obtain the symbolic form of any sentence or argument expressed in our ordinary language.

4.4 Truth Function :

The notion of function is frequently used in mathematics. Intuitively, an expression is said to be a function of its variable or variables if and only if the value of the expression is uniquely determined by the values of its variables. Consider the expression 'y = 2x'. Here the value of 'y' depends on the value of 'x' and hence 'y' is the function of x. This means, the moment we know the value of 'x', the value of y is unique and can be calculated in the usual way. For example, if x = 3, then y = 2 x 3 = 6. Similarly, in the expression '$z = x^2 + y^2 + 2$' z is a function with two variables x and y. In other words the value of z is uniquely determined by the values of x and y. Therefore, z is a function of x and y. Now this notion of function, which is frequently used in mathematics, can be extended to propositional logic. In propositonal logic we are concerned with truth functions. Every formula of propositional logic is either true or false but not both. This fact is used to consider any formula of propositional logic as a truth function of its propositional variables. Hence we may define truth function as follows An expression is said to be a truth function of its propositional variables if and only if the value of the expression is uniquely determined by the truth value of its propositional variables. For example, consider the expression '$(p \supset (\sim q \supset r)$.' This expression contains three distinct propositional variables p, q and r. Once we know the truth value of p,q and r, the value of $(p \supset (\sim q \supset r))$, is uniquely be determined by use of our basic truth tables explained earlier. For example, let Let p=T, q=F and r=T. Then we determine the

value of $(p \supset (\sim q \supset r))$ in the following manner.

(1)	(2)	(3)	(4)	(5)	(6)
p	q	r	$\sim q$	$(\sim q \supset r)$	$(p \supset (\sim q \supset r))$
T	F	T	T	T	T

Table- a

The columns 1,2 and 3 respectively assign the truth values of p,q and r. The fourth column calculates the truth value of $\sim q$. Since q = F, $\sim q$ must be T. The fifth column calculates the truth value of $(\sim q \supset r)$. Since $\sim q$ =T and r =T, the value of $(\sim q \supset r)$ is T. In the same way our sixth column determines the truth value of the whole formula $(p \supset (\sim q \supset r))$. The truth value of $(p \supset (\sim q \supset r))$ is determined by the truth value of p as given in the first column and the truth value of $(\sim q \supset r)$ as given in the fifth column. Thus, $(p \supset (\sim q \supset r)) = T$, as p = T and $(\sim q \supset r) = T$. Hence the truth value of $(p \supset (\sim q \supset r))$ is uniquely determined. Therefore, we say that $(p \supset (\sim q \supset r))$ is a truth function of its propositional variables such as p,q and r. Thus every formula of propositional logic is a truth function of its propositional variable or variables.

4.5 Construction of Truth Tables :

The truth table for a given formula represents in a systematic way all the truth-value assignments to it. For any given formula the total number of truth value assignments is fixed. If a formula contains one propositional variable then the total number of truth value assignments would be $2^1=2$. If it contains two distinct propositional variables then the total number of truth value assigments would be $2^2=4$. Thus if a formula contains n-number of distinct propsoitional variables then the total number of truth value assignments is 2^n. Any truth value assignment is determined by the truth value assigned to its propositional variables. Each row of a truth table represents the truth value assignment to the whole formula through the truth value assignments of its propositional variables. Each column of the truth table represents all possible truth value

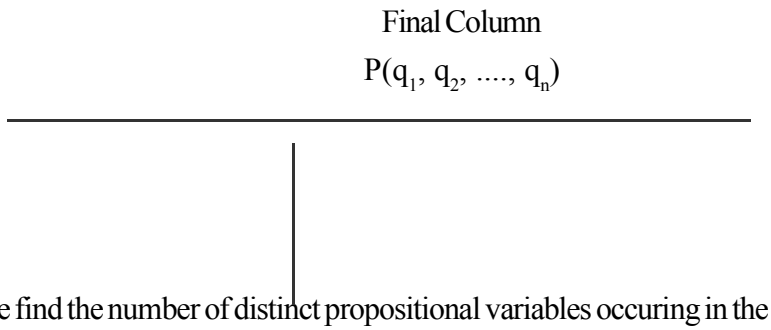
assignments to the component formulas of the given formula in question. Consider the following truth table for the formula $(p \supset (p \vee q))$.

p	q	$(p \vee q)$	$(p \supset (p \vee q))$
T	T	T	T
T	F	T	T
F	T	T	T
F	F	F	T

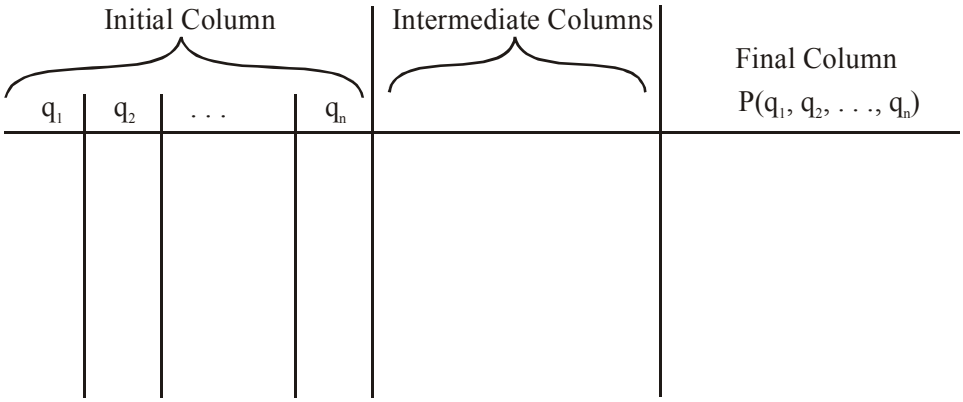
The above formula contains two distinct propositional variables 'p' and 'q'. Hence the total number of truth-value assignment would be $2^2 = 4$. So the above truth table has four rows, where each row represents a truth value assignment to the formula $(p \supset (p \vee q))$ through the truth value assignment of its propositional variables. For example, the second row represents a truth value assignments T to the formula through the truth value assignment of its propersitinal variable p and q. Under this assignment, the propositional variable p takes the truth value T and q takes the truth value F. This assignment yields the assignment T to the whole formula. Each row of the truth table represents a truth value assignment of the whole formula through the truth value assignment of its propositional variables. Further, since the number of component formulas of the formula $(p \supset (p \vee q))$ is four (i.e. the component formulas of $(p \supset (p \vee q)) = \{ p, q, (p \vee q), (p \supset (p \vee q))\}$ the truth table for it contains four distinct columns for each of the component formula. For example, the third column of the above truth table represents all truth value assignments to '$(p \vee q)$', that is a component formula of $(p \supset (p \vee q))$.

In what follows, we describe a general method of construction of the truth table for a given formula of propositional logic. Let $P(q_1, q_2, ..., q_n)$ be a formula with n-number of distinct propositional variables $q_1, q_2, ..., q_n$. We first construct the final column of the truth table by writing the whole formula $P(q_1, q_2, ..., q_n)$ on the extreme righthand corner of the truth table as

shown below :



Then we find the number of distinct propositional variables occuring in the formula. Since our given formula contains n-number of distinct propositional variables such as $q_1, q_2, ..., q_n$, we construct on the extreme lefthand side of the truth table n-number of distinct initial columns for each of these propositional variables as shown below:



Further, the number of intermediate column or columns is equal to the number of distinct non-atomic proper sub-formulas of $P(q_1, q_2, ... q_n)$. After construction of columns, we construct the rows for the truth table. The truth table for $P(q_1, q_2, ... q_n)$ must have 2^n number of rows as it contains n-number of distinct propositional variables. We construct the rows of the truth table as given below :

	Initial Column				Intermediate Columns	Final Column
	q_1	q_2	. . .	q_n		$P(q_1, q_2, . . ., q_n)$
First row						
Second row						
	⋮					
2^n th row						

After constructing columns and rows of the truth table we fill up truth values according to the following principle.

(i) We fill up the n^{th}- initial column by one 'T' followed by one 'F' alternatively. Then $(n-1)^{th}$-initial column is filled by two 'Ts' followed by two 'Fs' alternatively, similarly, $(n-2)^{th}$-initial column is filled by four 'Ts' followed by four 'Fs' alternatively. In this way we fill up the first initial column by equal number of 'Ts' follwed by equal number of 'Fs' alternatively. This may be shown as given below:

	Initial Column						Intermediate Columns	Final Column
	q_1	q_2	. . .	q_{n-2}	q_{n-1}	q_n		$P(q_1, q_2, ...q_n)$
First row				T	T	T		
Second row				T	T	F		
				T	F	T		
				T	F	F		
				F	T	T		
				F	T	T		
				F	F	T		
				F	F	F		
	⋮			⋮	⋮	⋮		

(ii) After filling up the initial columns the rest of the columns (i.e. intermediate and final columns) are filled up according to the basic truth tables.

Let us give an example to illustrate the construction of truth table for the formula $((p \supset q) \equiv (\sim q \supset \sim p))$. Clearly this formula contains two distinct propositional variables p and q. So the truth table for this formula will contain two initial columns (one column for 'p' and another column for 'q'). The final column of the truth table shows the truth value assigments for the whole formula $((p \supset q) \equiv (\sim q \supset \sim p))$. Since this formula has four distinct non-atomic proper sub-formulas viz., $\sim p$, $\sim q$, $(p \supset q)$, $(\sim q \supset \sim p)$, we construct four distinct intermediate columns for each of these formulas. Then the truth table of the formula will have four rows as it has two distinct propositional variables. Finally, truth values under different columns are entered according to the principle explained earlier. Thus, we construct the truth table for $((p \supset q) \equiv (\sim q \supset \sim p))$ as given below:

	Initial Column		Intermediate Columns				Final Column
	p	q	~ p	~ q	(p ⊃ q)	(~ q ⊃ ~ p)	((p ⊃ q) ≡ (~ q ⊃ ~ p))
First row	T	T	F	F	T	T	T
Second row	T	F	F	T	F	F	T
Third row	F	T	T	F	T	T	T
Forth row	F	F	T	T	T	T	T

For convenience we shall omit the names of columns and rows while constructing the truth-table for any formula. Thus, we may rewrite the above truth table as given below:

p	q	~ p	~ q	(p ⊃ q)	(~ q ⊃ ~ p)	((p ⊃ q) ≡ (~ q ⊃ ~ p))
T	T	F	F	T	T	T
T	F	F	T	F	F	T
F	T	T	F	T	T	T
F	F	T	T	T	T	T

Let us illustrate the construction of truth-tables for a few more formulas.

(I) $P \equiv \sim \sim P$

P	$\sim P$	$\sim \sim P$	$P \equiv \sim \sim P$
T	F	T	T
F	T	F	T

Here the formula ($P \equiv \sim \sim P$) has only one distinct propositional variable. So the truth table for it will contain just two rows. Since the formula contains two non-atomic component formulas namely $\sim p$ and $\sim \sim p$, we shall have two intermediate columns. Then we enter the truth values T and F starting from initial columns to the final column according to the instructions explained earlier.

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

p	q	$(p \cdot q)$	$((p \cdot q) \supset q)$
T	T	T	T
T	F	F	T
F	T	F	T
F	F	F	T

In this case, the formula $((p \cdot q) \supset q)$ has two distinct propositional varibales, p and q. Hence the truth table for it will contain $2^2 = 4$ rows. Further, the truth-table for this formula will have four columns for 'p' , 'q', '$(p \cdot q)$' and '$((p \cdot q) \supset q)$. Then we enter the truth values namely T and F according to the instruction given earlier.

(III) $(p \cdot \sim p)$

p	$\sim p$	$(p \cdot \sim p)$
T	F	F
F	T	F

IV. $((p \cdot q) \supset r)$

p	q	r	$(p \cdot q)$	$((p \cdot q) \supset r)$
T	T	T	T	T
T	T	F	T	F
T	F	T	F	T
T	F	F	F	T
F	T	T	F	T
F	T	F	F	T
F	F	T	F	T
F	F	F	F	T

4.6 Tautology, Contradiction and Contingent Propositions :

Tautology : The final column of truth table exhibits all possible truth value assignments. We can notice that there are three possible ways in which the final column of any truth table may exhibit the truth value assignments. These are (i) the final column contains only T's or (ii) it contains only F's or (iii) it contains both T's and F's. In the truth tables cited above you will notice that in examples I and II the final column contains only T's. In example III the final column contains only F's and in example IV the final column contains both T's and F's. A formula is called a *tautology* if and only if the final column of its truth table contains only T's. In other words a formula is called a tautology if and only if it is true for every truth value assignment. A formula is called *contradictory* if and only if the final column of its truth table contains only F's. In other words, a formula is contradictory only if it is false for every truth value assignment. Note that the denial of any tautologous formula is contradictionary and the denial of any contradiction is a tautology.

A fomula is called *contingent* if and only if the final column of its truth table contains both T's and F's. A contingent proposition is true for some truth value assignments and false for other

truth value assignments. Note that the denial of a contigent proposition is a contingent proposition. Thus, any formula of propositional logic is either a tautology or a contradiction or contingent.

Example - I

Let us find out whether the formula $(p \supset (p \vee p))$ is a tautology or not. For this, we construct below a truth table for the above formula.

p	$(p \vee p)$	$(p \supset p \vee p))$
T	T	T
F	F	T

Since the final column of the truth table of the formula $(p \supset (p \vee p))$ contains only the truth value T, $(p \supset (p \vee p))$ is a tutology. Note that $(p \supset (p \vee p))$ is true, whether the value of p is true or the value of p is false.

Example II : The truth table for $(p \,.\, q) \supset (p \vee q)$ can be given as follows

p	q	$p \,.\, q$	$p \vee q$	$(p \,.\, q) \supset (p \vee q)$
T	T	T	T	T
T	F	F	T	T
F	T	F	T	T
F	F	F	F	T

Since the final column of the truth table for the formula $(p \,.\, q) \supset (p \vee q)$ contains only T's the formula in question is a tatutology.

Example III : $((p \vee \sim p) \supset (p \,.\, \sim p))$

We construct below the truth table for the above formula.

P	$\sim p$	$(p \vee \sim p)$	$(p \,.\, \sim p)$	$(p \vee \sim p) \supset (p \,.\, \sim p)$
T	F	T	F	F
F	T	T	F	F

The final column of the above truth table contains only F's. So, the formula $((p \vee \sim p) \supset (p \,.\, \sim p))$ is a contradiction.

Example IV : $((p \supset q) \supset (p \,.\, q))$

We construct the truth table for the formula $((p \supset q) \supset (p \,.\, q))$ as shown below:

p	q	$(p \supset q)$	$(p \,.\, q)$	$(p \supset q) \supset (p \,.\, q)$
T	T	T	T	T
T	F	F	F	T
F	T	T	F	F
F	F	T	F	F

The final column of the above truth table contains T's and F's i.e. in the first and second rows, the formula $((p \supset q) \supset (p \,.\, q))$ takes the truth value T and in the third and fourth rows it takes the truth value F. So the formula in question is a contingent one.

The truth tabular method (or the method of direct truth table) developed so far provides a decision procedure for propositional logic in the sense that for any given formula, it is possible to decide in a finite number of steps whether the formula in question is a tautology or not.

4.7 Testing of Validity by Truth Tabular Method :

Let P and Q be any formula of propositional logic. We say Q tautologically follows from P (or P logically entails Q) if and only it ($P \supset Q$) is a tautology. The symbol " $\models$ " stands for "tautologically follows from" or "logical entailment". We use all these notions synonymously. The notion of tautological implication is an important notion in logic. Because the notion of validity of an argument can be defined by use of tautological implication. We say an argument is *valid* if and only if the implicative formula, constructed by forming the conjunction of premises as its antecedent and conclusion as its consequent is a tautology, otherwise the argument is invalid. In other words, given an argument, we construct an implicative formula, where the antecedent is a conjunction of premises and the consequent is the conclusion of the argument. Then we constuct the truth table for the implicative formula. If the formula is a tautology then the argument is valid. Otherwise it is invalid. Let us illustrate this procedure of testing validity or invalidity of arguments.

Example 1 : Either logic is interesting or not many students like it. In fact, many students like logic. Therefore, logic is interesting.

This argument may be translated into symbolic form as given below :

Let l stand for Logic is interesting, and m stand for many students like it

Translation of the argument into symbolic form :

$l \vee \sim m$

m

$\therefore l$

As explained earlier the above argument is valid if the implicative formula $(((l \vee \sim m) . m) \supset l)$ is a tautology. For this let us construct the truth table for the above formula :

l	m	~ m	(l ∨ ~ m)	((l ∨ ~ m) · m))	((l ∨ ~ m) · m) ⊃ l)
T	T	F	T	T	T
T	F	T	T	F	T
F	T	F	F	F	T
F	F	T	T	F	T

Clearly the formula $(((l \vee \sim m) . m) \supset l)$ is a tautology as we have only Ts in the final column of the truth table. Therefore, the argument is valid.

Example 2 : Sita is a singer and Gita is a dancer. Therefore, Sita is a singer.

The symbolic form of the argument is

$(p . q)$

$\therefore p$

The above argument would be valid if the formula $((p . q) \supset p)$ is a tautology. Let us construct the truth table for $((p . q) \supset p)$ to find out the validity of the argument.

p	q	p . q	((p . q) ⊃ p)
T	T	T	T
T	F	F	T
F	T	F	T
F	F	F	T

Since the formula $((p . q) \supset p)$ is a tautology, the above argument is valid. Hence we may say that p tautologically follows from $(p . q)$.

Symbolically, $(p . q) \models p$ holds.

Example 3 : If Ram is in Bhubaneswar then he is in Orissa. However, he is not in Bhubaneswar. Therefore, Ram is not in Orissa. This argument cab be expressed in symbolic form as follows.

$p \supset q$

$\sim p$

$\therefore \sim q$

To test the validity of this argument we construct below the truth table for the implicative formula $(((p \supset q) . \sim p) \supset \sim q)$.

p	q	$\sim p$	$\sim q$	$p \supset q$	$((p \supset q) \cdot \sim p))$	$((p \supset q) \cdot \sim p)) \supset \sim q)$
T	T	F	F	T	F	T
T	F	F	T	F	F	T
F	T	T	F	T	T	F
F	F	T	T	T	T	T

Clearly the formula $(((p \supset q) . \sim p) \supset \sim q)$ is not a tautology. Therefore, the argument is invalid.

When it is claimed that "$P \models Q$", what it means that whenever P is true, Q is also true, or that it is impossible for P to be true and Q to be false. This idea can be utilised to devise a simpler method of determining whether an argument is valid or not. We first construct the truth table for the argument consisting of columns for the premises and the conclusion. Then we look for a row, where the premises are true but the conclusion is false. If there is any such row then the argument is clearly invalid. But if there is no such row then the argument is valid.

Let us illustrate this procedure by the same argument given above (see example 3). We construct the truth table as shown below :

p	q	Premise $\sim p$	Premise $(p \supset q)$	Conclusion $\sim q$
T	T	F	T	F
T	F	F	F	T
F	T	T	T	F
F	F	T	T	T

In the above truth table, there is a row (the third row) where the premises are true but the conclusion is false. Therefore, the above argument is invalid.

Example 4 :

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

To test its validity let us construct the truth table as given below :

p	q	r	Premise $(p \supset q)$	Premise $(q \supset r)$	Conclusion $(p \supset r)$
T	T	T	T	T	T
T	T	F	T	F	F
T	F	T	F	T	T
T	F	F	F	T	F
F	T	T	T	T	T
F	T	F	T	F	T
F	F	T	T	T	T
F	F	F	T	T	T

Note that the premises $(p \supset q)$ and $(q \supset r)$ are true in the first, fifth, seventh and eighth rows and in such rows the conclusion $(p \supset r)$ is also true. Hence $(p \supset q), (q \supset r) \models (p \supset r)$ holds.

This can be shown in the following table that

$((p \supset q) \cdot (q \supset r)) \supset (p \supset r)$ is a tautology.

p	q	r	$(p \supset q)$	$(q \supset r)$	$(p \supset r)$	$(p \supset q).(q \supset r)$	$((p \supset q).(q \supset r) \supset (p \supset r)$
T	T	T	T	T	T	T	T
T	T	F	T	F	F	F	T
T	F	T	F	T	T	F	T
T	F	F	F	T	F	F	T
F	T	T	T	T	T	T	T
F	T	F	T	F	T	F	T
F	F	T	T	T	T	T	T
F	F	F	T	T	T	T	T

4.8 Indirect Method of Testing Validity :

We use truth table to test the tautologyhood of any formula of propositional logic. Further the validity of an argument is also tested by truth tabular method. This may be accomplished in two ways. The first method is as follows. For given argument, we construct an implicative formula with the conjunction of premises as its antecedent and the conclusion of the argument as its consequent. Then we construct a truth table for this formula. If this formula is a tautology then the argument in question is valid, otherwise it is invalid. In the second method we construct a truth table showing the truth value assignments of its premises as well as the conclusion. Then, if in all the rows where the premises are true, the conclusion is also true then the argument is valid. Otherwise it is invalid. In other words, if there exists at least one row in the truth table where premises are true but the conclusion is false, then the argument is invalid.

Though this direct truth tabular method is logically viable and mathematically correct, yet it is practically inconvenient. Because, if a formula contains more than three or four distinct propositional variables then we have to construct a very big truth table with large number of rows. Though it is theoretically possible, yet it would be time and space consuming and thus practically inconvenient. Moreover, if we can obtain the same result by means of a method that would consume less time and less space, certainly that would be preferable. The indirect method of truth table decision is one such method.

Indirect method, which is otherwise known as the method of *Reductio ad absurdum* (RAA in short) is a very old method of proof. The aim of this is to find a falsifying truth value assignment for the formula to be proved. Falsifying truth value assignment means assigning truth values to component formulas in such a way that the whole formula becomes false. If our search for such an assignment leads to an inconsistent assignment, then the formula is a tautology. Inconsistent assignment means assigning both T and F to any formula or to any of its component parts. Now let us demonstrate the indirect method of truth table decision.

The truth value assignment to the formula or to its component formulas are specified by writing the truth values beneath the main connective. Further, if the formula or the component formula is a propositional variable, we write its truth value beneath it. The step number for obtaining such a truth value assignment should be written just above the main connective. Again,

if the formula or the component formula is a propositional variable we write the step number just above it.

Examle I : Consider the formula $(p \supset (q \supset p))$. We test this formula by use of indirect method as shown below :

(2)	(1)	(3)	(2)	(3)
(p	$\supset$	(q	$\supset$	p))
T	F	T	F	F
				T

In this case the assumption of falsity of $(p \supset (q \supset p))$ leads to an inconsistent truth value assignment. So we conclude that the formula in question is a tautology.

In the above example at the first step we assign the truth value 'F' to $(p \supset (q \supset p))$. This is exhibited by writing the truth value 'F' beneath the main connective of formula. Further, since it is our first step we write the step number above the main connective of the formula. These two features are specified as shown below :

(1)
$(p \supset (q \supset p))$
F

The first truth value assignment leads to assigning 'T' to p and 'F' to $q \supset p$ simultaneously. We then represent second truth value assignment (that follows from the first assignment by use of truth tabular considerations) as shown below:

(2)	(1)	(2)
(p	$\supset$	$(q \supset p))$
T	F	F

Similarly, the assignment of 'F' to $(q \supset p)$ at the second step leads to assigning 'T' to q and 'F' to p at the third step. Hence we have

(2)	(1)	(3)	(2)	(3)
(p	$\supset$	(q	$\supset$	p))
T	F	T	F	F

T

At this statge, we have assigned truth values 'T' and 'F' both to p. The assumption that the whole formula could be false resulted in inconsistent truth value assignment. So the formula cannot take the truth value F in the main column. Therefore, the formula is a tautology. In this way, we can check whether a formula in propositional logic is a tautology or not by the indirect method.

Example I : $(p \supset (p \vee q))$.

We test $(p \supset (p \vee q))$ by indirect method as given below:

(2)	(1)	(3)	(2)	(3)
(p	$\supset$	(p	$\vee$	p))
T	F	F	F	F
				T

Exmple II : $((p \,.\, (p \supset q)) \supset q)$

The test of this formula by indirect method as shown below :

(2)		(1)	(2)
((p	. (p $\supset$ q))	$\supset$	q)
T		F	F
		T	

To test any argument by indirect method, we follow the same technique explained above. Consider the following argument. If there is increase in the money supply, there is inflation. If there is inflation, the Government will be unpopular. So, if there is increase in the money supply, the Government will be unpopular. This argument can be symbolised as follows :

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

To test it by indirect method, let us first construct the implicative formula, where the conjunction of premises is its antecedent and the conclusion as its consequent. Thus we have the

implicative formula : $(((p \supset q) . (q \supset r)) \supset (p \supset r))$. The above argument would be valid if this implicative formula is a tautology. We check this formula by assuming that the formula is not a tautology (i.e. there exists atleast one truth value assignment where the antecedent (the conjunction of premises) is true and the consequent (the conclusion) is false. If this assumption leads to any contradiction then the implicative formula is a tautology and the corresponding argument is valid. This may be shown as given below.

```
   4  5  2  2 6  4  5  1  3 2 3
((((p ⊃ q) .(q ⊃ r)) ⊃ (p ⊃ r))
   T  T  F  T F  T  F  F  T F F
      F
```

Thus, the assumption of the falsity of this formula results in inconsistency. So the formula is a tuatology and the argument is valid.

Let us test the validity of another argument. If Hari committed the crime then he was present at the scene. So, if Hari was not present at the scene, then he has not committed the crime. This argument can be symbolised as follows :

$(p \supset q)$

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

We test it as given below.

```
   5  2  5  1  3  4 2  3 4
((p ⊃ q) ⊃ (~ q ⊃ ~p))
   T  T  F  F  T  F F  F T
      F
```

Since truth of the premise together with the falsity of the conclusion leads to an inconsistent truth value assignment, the argument in question is valid.

We now test an argument which is invalid.

If Ashok is in Bhubaneswar, then he is in Orissa. Therefore, if he is in Orissa, then he is in Bhubaneswar.

We can symbolize the argument as follows :

$p \supset q$

$\therefore q \supset p$

We test it as given below :

```
4  2  4  1  3  2  3
(p  ⊃  q)  ⊃ (q  ⊃  P)
F  T  T  F  T  F  F
```

Notice that the above argument is invalid. Because, the assignment of "truth" to the premise and "falsity" to the conclusion does not lead to any inconsistent truth value assignment.

In this manner we may test the validity of any argument of propositional logic. Thus, the indirect method, like our direct truth tabular method, provides a decision procedure for propositional logic.

8.9 Important Tautological Implications and Equivalences :

We note the following tautological implications to be used in the theory of deduction developed in the next section. For any formula P, Q and R of propositional logic the following laws are valid. Students are advised to test these following tautological implications and tautological equivalences both by direct and indirect method of truth table decision.

1. **Modus ponens (MP)**

   $(P \supset Q)$
   P
   $\therefore Q$

2. **Modus tollens (MT)**

   $(P \supset Q)$
   $\sim Q$
   $\therefore \sim P$

3. **Hypothetical Syllogism**

   $(P \supset Q)$
   $(Q \supset R)$
   $\therefore (P \supset R)$

4. **Disjunctive Syllogism**

   $(P \vee Q)$
   $\sim P$
   $\therefore Q$

5. **Constructive Dilemma (C D)**

   $((P \supset Q) \cdot (R \supset S))$
   $(P \vee R)$
   $\therefore (Q \vee S)$

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

$\therefore P \vee Q$

In what follows we will use these nine tautological implications together with a set of tautological equivalences as given below to develop the theory of formal deduction for propositional logic.

Tautological equivalence

Let P and Q be any formula of propositional logic. Then P and Q are tautological equivalent to each other if and only $(p \equiv Q)$ is a tautology.

For example, p tautologically equivalent to $\sim\sim p$. To test this let us construct below the truth table for $(p \equiv \sim\sim p)$ and if this formula is a tautology then p tautologically equivalent to $\sim\sim p$.

P	~P	~ ~ P	P ≡ ~ ~ P
T	F	T	T
F	T	F	T

This truth table shows that $p \equiv \sim\sim p$ is a tautology. So, we claim that p is tautologically equivalent to $\sim\sim p$.

We note the following ten important tautological equivalences that will be necessary for developing the theory of formal deduction in our next section.

10. **De Morgan's rule (DeM.)**

$\sim (P \cdot Q) \equiv (\sim P \vee \sim Q)$

$\sim (P \vee Q) \equiv (\sim P \cdot \sim Q)$

11. **Commutation (com)**

$((P \vee Q) \equiv (Q \vee P))$

$((P \cdot Q) \equiv (Q \cdot P))$

12. **Association (Assoc)**

$((P \vee (Q \vee R)) \equiv ((P \vee Q) \vee R))$

$((P \cdot (Q \cdot R)) \equiv ((P \cdot Q) \cdot R))$

13. **Distribution (Dist.)**

$((P \cdot (Q \vee R)) \equiv ((P \cdot Q) \vee (P \cdot R)))$

$((P \vee (Q \cdot R)) \equiv ((P \vee Q) \cdot (P \vee R)))$

14. **Double negation (DN)**

$(P \equiv \sim \sim P)$

15. **Transpostion (Trans)**

$((P \supset Q) \equiv (\sim Q \supset \sim P))$

16. **Law of Implication (Impl.)**

$((P \supset Q) \equiv (\sim P \vee Q))$

17. **Law of Equivalence (Equiv.)**

$((P \equiv Q) \equiv ((P \supset Q) \cdot (Q \supset P)))$

$((P \equiv Q) \equiv ((P \cdot Q) \vee (\sim P \cdot \sim Q)))$

18. **Exportation (Exp.)**

$(((P \cdot Q) \supset R) \equiv (P \supset (Q \supset R)))$

19. **Tautology (Taut)**

$(P \equiv (P \vee P))$

$(P \equiv (P \cdot P))$

By use of truth tablular method we easily verify that all these above biconditionals are tautologies. Note that in each of the above cases the left part is tautologically equivalent to the right part and conversely.

4.10 The Method of Deduction :

The truth tabular method is practically inconvenient for the reasons discussed earlier. The indirect method is also not always practically suitable. In some cases, the initial truth value assignment leads to alternative cases of truth value assignments and each such cases again may lead to the alternative subcases of truth value assignments. This might result in clumsiness. Further, it would be very difficult to keep track of all such cases and subcases of truth value assignments to the formula. This is evident in cases of some biconditional formulas. Hence, it is necessary to develop a general proof procedure for testing of arguments that avoids these drawbacks. In what follows we develop a proof procedure to test the validity or invalidity of arguments of propositional logic.

The general procedure that we wish to develop is determined by a set of rules called the rules of inference. These rules are nothing but the important nine tautological implications and ten tautological equivalences described earlier. Thus, we have nineteen rules of inference in all. Let us explain the application of these nineteen rules.

Consider the following argument

$$\begin{array}{l} p \\ \sim p \\ \therefore\ r \end{array}$$

The derivation of the conclusion r from premises 'p' and '~p' is as follows:

1.	p	
2.	$\sim p$	$\mid \therefore r$
3.	$p \vee r$	1, Add.
4.	r	2, 3 D.S

The above sequence of formula consistitute a proof of r from the premises 'p' and '~ p'. This proof contains four lines (i.e. a four line sequence of formulas of prepositional logic) written vertically from top to bottom. It has two columns. The first left hand column is a sequence of

formulas such that in the above case, p is the first formula '$\sim$ p' is the second formula, '$(p \vee r)$' is the third formula and 'r' is the fourth formula which is the desired conclusion. In other words, 1, 2, 3, and 4 written left to each formula are the step numbers for these formulas. The second column is the justificatory column. It justifies the occurrence of a formula in the first column. We write the justification for a given line in a proof just on the right side of that formula. A line of the proof for which no justification is written is a premise of the argument. In the above example, we have no justification for the line 1 and 2 and thus we say that the formula in line 1 and 2 are our premises. Further, we write the conclusion just on the right side of the last premise preceeded by the symbol "$|\therefore$" as shown above. The line 3 is obtained from line 1, by using the law of addition. So we write '1, Add', on the right side of line 3 as the justification for it. Similarly line 4 is obtained from (2) and (3) by use of the rule D. S. (i.e. disjunctive syllogism). So we write 2, 3, D.S. on the right side of the fourth line as the justification.

Consider another symbolic argument.

$(c \supset (d \supset b))$
$(\sim g \vee c)$
d
$\therefore (g \supset b)$

The derivation of $(g \supset b)$ from $(c \supset (d \supset b))$, $(\sim g \vee c)$ and d may be shown as given below.

1.	$c \supset (d \supset b)$	
2.	$(\sim g \vee c)$	
3.	d	$\mid \therefore (g \supset b)$
4.	$(g \supset c)$	2, Impl.
5.	$(g \supset (d \supset b)$	4, 1 H.S
6.	$((g . d) \supset b)$	5, Exp.
7.	$((d . g) \supset b)$	6, Com.
8.	$(d \supset (g \supset b))$	7, Exp.
9.	$(g \supset b)$	8, 3 M.P

Proved

Example

$(a \supset b)$

$(c \supset \sim b)$

$\therefore (a \supset \sim c)$

1.	$(a \supset b)$	
2.	$(c \supset \sim b)$	$\mid \therefore (a \supset \sim c)$
3.	$(\sim \sim b \supset \sim c)$	2, Trans
4.	$(b \supset \sim c)$	3, DN
5.	$(a \supset \sim c)$	1, 4 H.S.

Proved

By using the method of derivation as explained above we can test the validity of any given argument in propositional logic in a finite number of steps. Therefore, the method of deduction described above provides a decision method for propositional logic.

4.11 Inconsistency and Indirect Proof :

In our previous chapter we explained the method of fomal deduction. Sometimes we are not interested in deriving the conclusion from the given set of premises, rather our interest is to see whether a given set of premises is consistent or not. This, very often, is the case in a law court. A lawyer while cross-examining a witness, aims at discrediting the evidences presented by the witness, just by deriving an inconsistency in the set of evidences. Since an inconsistent proposition is always false, the set of premises, from which an inconsistent proposition is deduced is bound to be unsatisfiable (i.e. no consistent truth value assignments can be found for such a set of formulas). To begin with we say that two propositions are said to be contradictory if one is the negation of the other. Thus, a contradiction is a conjunction of two contradictory propositions and is of the form $(p . \sim p)$. Now we define a set Σ of propositions to be inconsistent if and only if a contradiction is derivable from Σ.

$(p \supset q)$

$(q \supset r)$

$(s \supset \sim r)$

$(p . s)$

To show the inconsitency of the above set of premises let us construct a formal derivation of contradiction from the above set of premises.

1. $(p \supset q)$

2. $(q \supset r)$
3. $(s \supset \sim r)$
4. $(p . s)$
5. p 4, simp.
6. s 4, simp.
7. q 1, 5, M.P.
8. r 2, 7, M.P.
9. $\sim s$ 3, 8, M.T.
10. $(s . \sim s)$ 6, 9, conj.

Since a contradiction of the form $(s . \sim s)$ is derivable from the above set of premises, the set of premises in question is inconsistent.

Further, by using the notion of inconsistency we define the notion of validity of an argument. We say an argument is valid if and only if the set of the premises together with the denial of the conclusion is inconsistent. The proof of the conclusion through an inconsistency is called an indirect proof. The indirect proof is otherwise known as proof by *reductio ad absurdum* (or RAA). We may state R.A.A. as follows. If a contradiction is derivable from a given set of premises together with the negation of the conclusion then the conclusion follows from the given set of premises alone.

Here we state the premises of an agrument as given. Then we take the negation (or the denial) of the conclusion as an additional premise. Now if any contradiction is derivable from the above set of premises then we claim by R.A.A. that our original conclusion logically follows from the premises alone.

We illustrate below an indirect method of formal derivability. Consider the following argument.

$(a . b)$

$(a \vee c) \supset d$

$\therefore (a . d)$

1. $(a . b)$
2. $(a \vee c) \supset d \quad | \therefore (a . d)$

3.	~ (a . d)	the denial of the conclusion.
4.	(~a ∨ ~ d)	3, DeM.
5.	a	1, simp.
6.	~ d	5, 4, D.S.
7.	(a ∨ c)	5, Add.
8.	d	2, 7, M.P.
9.	(d. ~ d)	6, 8, Conj.
10.	(a . d)	3, 9, R. A. A.

Note that we follow the same method of formal derivability or use the same set of rules of inference to derive the conclusion from the given set of premises or we test the inconsistency of a set of premises. But there is an essential difference between direct and indirect proof. In case of the former the terminal point of the derivation is fixed in advance whereas in the case of the latter, the terminal point is any contradiction.

4.12 Proof of Invalidity :

We provided a formal proof for argument by deriving the conclusion from its premises where the argument is valid. On the other hand, not being able to construct a formal proof for an argument does not necessarily prove that the argument is invalid. Because, we might not have tried enough or tried in the right direction to discover the proof. So, not being able to construct a proof is not a sure sign of the invalidity of the argument. To show the invalidity we have to rely on a different method.

The method we follow here is closely related to our truth tabular method. It is actually much shorter than the truth tabular method. To prove the invalidity of an argument by use of truth table, we have to construct the full truth table for the premises as well as for the conclusion. Then if there is a row in the truth table where the premises are all true but the conclusion is false, we declare that the argument is invalid. In the present method, we will not construct the full truth table for the argument but by use of truth tabular consideration we discover a truth value assignment to the propositional variables occurring in the argument such that it makes all the premises true together and conclusion false.

To illustrate this let us consider the following argument:

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

Here we prove its invalidity without constructing a complete truth table. Our aim is to find a truth value assignment which make the premises true and conclusion false. For this, let us ask what truth value assignment is required to make the conclusion false? Clearly, to make '$\sim q$' false we have to assign T to 'q' true. Similarly, let us ask what truth value assignment is required to make all premises true together? To make '$\sim p$' true we have to assign 'p' false. Obviously, since 'p' is false, $(p \supset q)$ is true. Thus, we find a truth value assignment to the propositional variables occurring in the argument which makes the premises true and the conclusion false. This may be shown as ginen below:

p	q	$(p \supset q)$	$\sim p$	$\sim q$
F	T	T	T	F

So it is proved that the above argument is invalid.

We prove the invalidity of the following argument as given below :

$a \supset b$
$c \supset d$
$a \vee d$
$\therefore b \vee c$

a	b	c	d	$(a \supset b)$	$(c \supset d)$	$(a \vee d)$	$(b \vee c)$
F	F	F	T	T	T	T	F

Clearly this demonstrates a truth value assignment that makes all the premises true and the conclusion false. So the argument is invalid.

SUMMARY

Propositional logic is a part of Symbolic logic. It consists of three types of symbols. These are (i) Propositional variables, (ii) Connectives and (iii) a pair of parenthesis. We use lower case English letters as symbols for propositional variables. There are five basic truth - functional connectives. These are negation, conjunction, disjunction, implication and equivalence. These are symbolised by '$\sim$' (tilde or curl), '.' (dot), '$\vee$' (vel or wedge), '$\supset$' (horseshoe) and '$\equiv$' (triple bar) signs respectively. All these connectives are truth function in character. For any proposition p, the truth value of $\sim$ p is uniquely determined by the truth value of p. If p is true the truth value of $\sim$ p is false and if p is false, the truth value of $\sim$ p is true. For any proposition p and q (p.q) is true if both p and q are true and false otherwise. The proposition ($p \vee q$) is false, if both p and q are false, and in all other possibilities it is true. The implicative proposition ($p \supset q$) is false if p is true and q is false and is true otherwise. Similarly, ($p \equiv q$) is true when both p and q have the same truth value and false when p and q have different truth values. We have discussed the method of translating sentences and arguments in oridinary language into propositional symbolism.

We have explained the methods of construction of truth tables for any compound propositions. It is important to remember that the number of truth value assignments (i.e. the number of rows in the truth table) is determined by the number of distinct propositional variables occurring in the compound proposition. A formula containing n - number of distinct propositional variables willl have 2^n - number of rows in the turth table. By use of truth table we determine whether a formula is a tautology or a contradiction or a contingent proposition. If the final or the main column in the truth table contains only, T's then the proposition is a tautology ; if it contains only F's then the proposition is a contradiction and if it contains both T's and F's then the proposition is a contingent one.

We have introduced the notion of validity and explain the method of testing the validity of arguments by truth tabular method. We first symbolise the given argument. Then we construct an implicative formula by taking the conjunction of premises as the antecedent and the conclusion as the consequent. If the implicative formula so constructed is a tautology then the argument is valid. Otherwise the argument is invalid.

The indirect (or shorter) method of truth table decision starts from the assumption that the argument is invalid. Then it will have at least one truth value assignment in which the premises are all true but the conclusion is false. If this assumption leads to any inconsistent truth value assignment then the argument is valid. Otherwise the argument is invalid.

The method of deduction for testing the validity of arguments in propositional logic has been explained with examples. Correspondingly the method of proving the invalidity of an argument is given by constructing counter examples.

MODEL QUESTIONS

Objective type questions :

I. Let A = Asok plays football.
B = Binod plays cricket.
C = Chitta is a singer.
Symbolize the following propositions. (The first one has been answered for you.)

1. Either Asok plays football or Binod plays cricket. A v B
2. Binod plays cricket and Chitta is a singer.
3. If Asok plays football, then Binod plays cricket
4. It's not the case that Chitta is a singer.
5. If Chitta is not a singer, then Asok does not play football.
6. Asok plays football if and only if Binod does not play cricket.
7. Asok plays football only if Binod plays cricket.
8. If Chitta is a singer, then Asok plays football or Binod plays cricket
9. Neither Binod plays cricket nor Chitta is a singer.
10. Asok plays football provided Binod plays cricket.

II. Fill in the blanks by using 'true' or 'false' whichever is appropriate.

1. A conjunction is true if and only if both its conjuncts are _____.
2. A conditional is false if and only if its antecedent is _____ but its consequent is _____.
3. If A is true and B is false, then "A . B" is _____.
4. If A is false and B is false, then "A ⊃ B" is _____.
5. If A is false and B is false, then "A . B" is _____.
6. If A is true and B is true, then "A ∨ B" is _____.
7. If A is false and B is false, then "A ≡ B" is _____.
8. If A is false and B is true, then "A ⊃ B" is _____.
9. If A is false and B is true then "A ≡ B" is _____.
10. If A is false and B is false, then "A ∨ B" is _____.

11. If A is true and B is true, then "A $\supset$ B" is _____.
12. If A is true and B is true, then "A . B" is _____.

III. Construct truth tables for the following formulas and point out in each case whether the formula is tautologous, self-contradictory, or contingent.

1. $p \supset p$
2. $p \supset q$
3. $p \vee \sim p$
4. $p \cdot q$
5. $\sim (p \cdot \sim p)$
6. $\sim (p \vee \sim p)$
7. $p \supset (p \vee q)$
8. $p \supset (p \cdot q)$
9. $(p \cdot q) \supset p$
10. $(p \vee q) \supset (q \vee p)$
11. $(p \cdot q) \equiv (q \cdot p)$
12. $(p \supset q) \supset (\sim p \supset \sim q)$
13. $(p \supset q) \supset (\sim q \supset \sim p)$
14. $(p \supset q) \supset (p \vee q)$
15. $((p \supset q) \cdot (q \supset r)) \supset (p \supset r)$

IV. Point out in each case whether the statement is true or false.

1. The '$\supset$' is a truth-functional connective.
2. '$(p \supset p)$' is a tautology.
3. '$(p \cdot q)$' is contingent.
4. '$\sim (p \vee \sim p)$' is contradictory.
5. All connectives are truth-functional connectives.
6. '$(q \vee \sim q)$' is contingent.
7. '$(q \supset (p \vee \sim p))$' is a tautology.
8. '$((p \supset p) \vee (q \cdot p))$' is a tautology.
9. A contingent statement is sometimes false.

10. The statement '$(p \equiv q)$' is contingent.
11. The statement '$((p \supset q) \vee (q \supset p))$' is contingent.
12. The statement '$((p \,.\, \sim p) \supset q))$' is contingent.

V. Answer the following by choosing the correct option.

1. Which of the following best symbolizes "Binod sings only if Chandra dances"?
   a) $(B \supset C)$
   b) $(C \supset B)$
   c) $(B \equiv C)$
   d) $(B \vee C)$
2. Which of the following best symbolizes "Binod sings if Chandra dances"?
   a) $(B \equiv C)$
   b) $(B \supset C)$
   c) $(C \supset B)$
   d) $(B \vee C)$
3. Which of the following pairs of sentences is a logically equivalent pair?
   a) $(A \vee B)$ --- $(A \,.\, B)$
   b) $\sim(A \vee B)$ --- $(\sim A \,.\, \sim B)$
   c) $\sim(A \,.\, B)$ --- $(\sim\sim A \,.\, \sim\sim B)$
   d) $\sim(A \vee B)$ --- $(\sim A \vee \sim B)$
4. Which of the following is a symbolization of "Neither Rabi nor Girish is a boarder in the hostel".
   a) $(\sim R \supset \sim G)$
   b) $(\sim R \,.\, G)$
   c) $\sim(R \vee G)$
   d) $\sim(R \,.\, G)$
5. If "A" is true and "B" is false, which of the following is false?
   a) $(A \,.\, \sim B)$
   b) $(\sim\sim A \vee \sim B)$
   c) $(\sim A \vee \sim\sim B)$
   d) $(\sim A \equiv B)$
6. Which of the following is a correct symbolization for "Either Asok or Biranchi is the President

of College union if and only if Yaqub is not."

a. $(\sim Y \supset (A \vee B))$
b. $((A \vee B) \supset \sim Y)$
c. $((A \vee B) \equiv \sim Y)$
d. $((A \vee B) \equiv Y)$

7. A tautology is
   a. always true.
   b. sometimes true and sometimes false.
   c. never true.
   d. none of the above.
8. A truth table for '$(\sim A \supset \sim B)$' will have
   a. 2 rows.
   b. 4 rows.
   c. 8 rows.
   d. 6 rows.
9. A truth table for '$(A \supset B) \equiv (\sim B \supset \sim A)$ will have
   a. 2 rows.
   b. 4 rows.
   c. 8 rows.
   d. 16 rows.
10. A truth table for '$(A \vee B) \supset (C \vee D)$' will have
    a. 4 rows.
    b. 8 rows.
    c. 16 rows.
    d. 32 rows.
11. A truth table shows that a proposition is contradictory if and only if
    a. it is true on all rows of the table.
    b. it is true on some but not all rows of the table.
    c. it is true on no rows of the table.
    d. it is false on most of the rows of the table.
12. A truth table shows that a proposition is contingent if and only if
    a. it is true on all rows of the table.
    b. it is true on some but not all rows of the table.
    c. it is true on no rows of the table.
    d. it is true on most of the rows of the table.

VI. Point out which of the following arguments are valid and which are invalid.

1. If you overeat, you will suffer from indigestion.
   You are not suffering from indigestion.
   Therefore, you have not overeaten.
2. If Asok has committed the murder, then he was in Puri at the time of murder.
   But Asok was not in Puri at the time of murder.
   Therefore, Asok has not committed the murder.
3. If there is flood or cyclone then the State receives relief assistance from the Centre.
   The State has not received relief assistance from the Centre.
   Therefore, there is no flood.
4. Either Nabin is getting scholarship or he is doing private tuition.
   However, Nabin is not getting any scholarship.
   Therefore, Nabin is doing private tuition.
5. Sita will study science if and only if Gita will study science.
   Sita will not study science.
   So, Gita will not study science.

VII. For each the following valid arguments state the rule of inference by which the conclusion is derived from the premise or premises.

(1) $(p \supset q)$
$\therefore ((p \supset q) \vee (r \cdot s))$

(2) $((p \vee q) \cdot (s \cdot r))$
$\therefore (s \cdot r)$

(3) $(p \supset q)$
$\sim q$
$\therefore \sim p$

(4) $(\sim (p \cdot s) \supset (q \vee r))$
$\sim (p \cdot s)$
$\therefore (q \vee r)$

(5) $((p \vee q) \supset (p \supset r))$
$\sim (p \supset r)$
$\therefore \sim (p \vee q)$

Essay type Questions

1. Explain the basic connectives of propositional logic.
2. Distinguish between disjunction and alternation. Is alternation a basic connective? Discuss.
3. Explain, with examples, the method of construction of truth tables.
4. Is the direct truth tabular method a decision method? Discuss with examples.
5. Explain the indirect method of truth table decision.

6. Construct a formal proof of validity for the following arguments. For any proposition p, q, r, s and t.

(a) $(p \supset q)$
$(p \vee (r \cdot s)$
$(\sim q \cdot \sim t)$
$\therefore r$

(b) $((p \vee q) \supset (r \cdot s))$
$((r \cdot s) \supset (t \cdot q))$
p
$\therefore t$

(c) $(p \cdot q)$
$((p \vee r) \supset s)$
$\therefore (p \cdot s)$

(d) $(t \supset s)$
$((t \cdot s) \supset r)$
$\sim (t \cdot r)$
$\therefore \sim t$

7. Prove (a) to (d) of (6) by using R.A.A.

8. Prove the invalidity of the following by the method of assigning truth values.

(a) $(p \supset q)$
$(s \supset r)$
$(p \vee r)$
$\therefore (q \vee s)$

(b) $(p \supset q)$
$(q \supset r)$
$\therefore (q \supset p)$

(c) $p \supset q$
$\sim p$
$\therefore \sim q$

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

***

CHAPTER - 5
FALLACIES

5.1 What is a fallacy?

A fallacy is a mistake in reasoning. Although mainly fallacies concern mistakes in arguments, some fallacies relate to explanations, definitions, or other instances of reasoning. For instance making a contradictory claim, putting forward a question with unwarranted presuppositions, misinterpreting a statement by putting wrong emphasis on a word or phrase in it and the like are counted as fallacies, even when these are not part of any argument. So, broadly speaking, fallacies can be characterized as mistakes of reasoning, whether or not the mistakes take the form of an argument. On the other hand, a fallacy is different from a factual mistake. If you say that Odisha has twenty districts, when in fact it has thirty, you commit a factual mistake, not a fallacy.

Study of different forms of fallacies can help us to improve our ability to argue well. In order to improve our ability to reason properly we should study not only instances of good reasoning but also examples of reasoning that are defective in some way or other. If we are familiar with these mistakes, we can avoid committing them. Further, we would also be able to detect such mistakes in the arguments of others. So a systematic study of fallacies will help us to detect errors in the arguments of others as well as guard us from committing such mistakes in our own arguments.

A good argument should have the following features. First and foremost, the premises should provide adequate support to the conclusion. In a deductive argument the premises should provide conclusive support to conclusion and in an inductive argument the premises should provide strong support to the conclusion. Further a good argument should have all true premises. However, determining the truth or falsity of premises is not the special task of logic. So in our discussion of

fallacies, we will not be concerned with defects in reasoning arising out of factual errors or mistakes in belief and thought. There are also other requirements of a good argument. A good argument should be clearly stated, it should avoid circularity, ambiguity and emotional language. A good argument should also be relevant to the issue at hand. When any of these conditions is violated an argument can be defective. Moreover we shall be concerned with those mistakes that are very tempting to make. In other words, fallacies are those defective arguments that, although incorrect, appear to be correct. Some patterns of mistake occur so frequently that logicians have found it useful to give names to these recurring errors. Many of these fallacies also have Latin names. One advantage of learning fallacies by their names is that one can detect these mistakes in actual arguments and guard oneself against these pitfalls.

Since arguments are either deductive or inductive, fallacies are often discussed both in deductive and inductive logic. Fallacies can be broadly classified into formal and informal fallacies. Fallacies which arise due to violation of the rules of inferences are called formal fallacies. A formal fallacy can be detected by examining the logical form of the argument. An informal fallacy takes into account the content of the arguments and the purpose of the reasoning.

5.2 Formal Fallacies :

We have already discussed in the previous chapters the various formal fallacies in course of discussion of the various rules of immediate inferences. Here we will make a brief mention of some of these formal fallacies.

Fallacies of Immediate Inference :

Fallacies of immediate inference occur when the rules of different types of immediate inference are violated. One such fallacy is the fallacy of illicit conversion. This fallacy occurs when we make a simple conversion of an A-proposition. The argument "All cats are mammals. Therefore, all mammals are cats" is fallacious. The term 'mammal' is distributed in the conclusion without being distributed in the premises. This fallacy is also committed when we convert an O-proposition. Consider the following argument. "Some females are not aunts. Therefore, some aunts are not females." In this argument the term 'female' is not distributed in the premise, but it is distributed in the conclusion. It can easily be noticed that in each of the above arguments, even though the premise is true, the conclusion is false. Contraposition of I-proposition is also fallacious. Fallacies may occur when the rules of immediate inference based on the traditional square of

opposition of propositions are violated. For example, in case of contrary relation from the falsity of one of the contraries we cannot infer the truth of the other. So also in subcontrary relation from the truth of one the falsity of the other cannot be inferred. Violation of rules of inference in case of subalternation and contradictory relations also lead to formal fallacies.

Mediate Deductive Fallacies :

Categorical syllogisms are the foremost forms of mediate deductive arguments. When any of the rules of categorical syllogistic argument is violated a fallacy is committed.

Fallacy of Four Terms : A valid categorical syllogism, by definition, must have exactly three terms. An argument commits the fallacy of four terms, if it purports to be a valid categorical syllogism, but has four or more terms. So a purported catergorical syllogism that contains more three terms commits this fallacy.

The following argument commits the fallacy of four terms :
All men who write books are authors.
All educated men could write books.
Therefore, all educated men are authors.

Here the middle term is changed from actual writing of books to having the potentiality to write books. One who actually writes books is an author and one who does not write any book is not an author even if he or she has the potentiality to write books.

Sometimes a term is used in two different senses in an argument. In such a case we can say that the fallacy of equivocation is committed. We shall discuss this fallacy under the list of informal fallacies.

Undistributed Middle : In a categorical syllogism the middle term must be distributed at least once in order to establish the relation between the major and minor terms in the conclusion. If the middle term is not distributed in at least one of the premises, there arises the fallacy of undistributed middle. This fallacy is committed in the following argument :

All dogs are mammals.
All cats are mammals.
Therefore, all cats are dogs.

Illicit Major and Illicit Minor : If the major term or the minor term is distributed in the conclusion

without being distributed in the respective premise the argument becomes fallacious. The following argument commits the fallacy of illicit major.

All dogs are mammals.
No cats are dogs.
Therefore, no cats are mammals.

The fallacy of illicit minor arises in the following example.

All voters are adults.
All voters are citizens.
Therefore, all citizens are adults.

Affirmative Conclusion from a Negative Premise : In a categorical syllogism if one premise is negative the conclusion will be negative. So deriving an affirmative conclusion from a negative premise is fallacious. This fallacy is committed in the following argument.

All judges are educated.
Some lawyers are not judges.
Therefore, some lawyers are educated.

Exclusive Premises : Any form of categorical syllogism with two negative premises commits this fallacy. The following argument illustrates this fallacy.

No birds are mammals.
No dogs are birds.
Therefore, no dogs are mammals.

In addition to these fallacies of categorical syllogism, one should guard oneself against two other common fallacies that might affect deductive arguments. These are the fallacies of affirming the consequent and denying the antecedent.

Fallacy of Affirming the Consequent : In a deductive argument by affirming the consequent of a conditional or implicative proposition one cannot affirm or deny its antecedent. So any deductive argument of the following form is invalid.

If A then B
B
Therefore, A

The following argument commits this fallacy.

If Hari is in Bhubaneswar, then he is in Odisha.
Hari is in Odisha.
Therefore, Hari is in Bhubaneswar.

This argument is invalid. It can easily be imagined that even though the premises are true, the conclusion could be false. Hari might be in Rourkela.

Fallacy of Denying the Antecedent : The fallacy consists in proceeding to argue by denying the antecedent of a conditional proposition. By denying the antecedent of a conditional proposition one cannot proceed to deny the consequent. So any argument of the following form is invalid :

If A then B
Not A
Therefore, not B

The following argument is invalid and it commits the fallacy of denying the antecedent.

If Asok is in Bhubaneswar then he is in Odisha.
Asok is not in Bhubaneswar.
Therefore, Asok is not in Odisha.

It can be notice that even though the premises are true, the conclusion might be false. Asok could be in Berhampur or any where in Orissa other than Bhubaneswar, which would make the premises true but the conclusion false.

5.3 Informal fallacies :

Under the informal fallacies we will discuss some of the most common mistakes in reasoning. Informal fallacies can be classified under three heads viz., fallacies of relevance, fallacies of presumption, and fallacies of ambiguity.

(a) Fallacies of Relevance :

When the premises in an argument do not provide relevant reason for believing the truth of the conclusion, this fallacy is committed. In other words, when the premises are not relevant to the conclusion the fallacy of relevance is committed. This fallacy has many forms. appeal to force, appeal to pity, appeal to the people, appeal to authority, argument against the person (abusive, circumstantial, tu quoque), appeal to ignorance, and irrelevant conclusion are important forms of this fallacy.

Appeal to Force (*argumentum ad baculum*) : This fallacy occurs when one uses a threat of force instead of logically relevant reasons in support of a claim. Fallacious appeal to force occurs when the person arguing for a proposal tells that unpleasant consequences will follow if it is not accepted. It is reflected in the slogan "Might is right". While issuing a threat might be an effective way to get someone agree to your proposal, it offers no grounds for believing that it is true. The fallacy is committed in the following examples :

(i) You must agree that my proposal is correct. You will be dismissed from your job if you do not accept it.

(ii) What the scripture says must be true, because if you refuse to accept its truth the gods will punish you.

Appeal to Pity (*argumentum ad misericordiam*) : Fallacious appeal to pity occurs when an arguer tries to evoke pity instead of citing logically relevant reasons to accept a conclusion. This fallacy is committed when someone appeals to pity for the sake of getting a conclusion accepted. It should be borne in mind that one's pitiful state has nothing to do with the truth of the proposition one is arguing for. For example, an examinee who pleads that he deserves pass mark on the ground that his parents are very poor or that his mother is ailing is appealing to pity. The poverty, illness of his mother and the unfortunate consequences that will follow if he fails are not relevant to the issue of how much mark he deserves.

Appeal to the People (*argumentum ad populum*) : "*Argumentum ad populum*" literally means "argument to the people". This fallacy is committed when someone argues that a proposition is true because it is widely held to be true or is held to be true by some elite sector of the population. The appeal also often relies upon emotively charged language to arouse strong feelings that may lead an audience to accept its conclusion. This fallacy has many names. This is also known as Appealing to the Gallery, Appeal to Emotion, or Appealing to the Crowd. Consider, for example, the advertisement: "Join the Pepsi generation!" It declares that by drinking Pepsi you will be a part of an elite group. But it tells us nothing about the qualities of the soft drink. If it is put forth as a part of an argument, it will be fallacious. Consider the following argument :

> The vast majority of people believe that capital punishment has a great deterrent effect. So this must be the correct view.

Here an appeal has been made to the majority opinion in support of the claim that capital punishment has great deterrent effect.

Appeal to Authority (*argumentum ad verecundiam*) : Sometimes an appeal is made to the opinion of famous persons to win support for an assertion. Appeal to authority is inappropriate when the person cited is not qualified to have an expert opinion on the subject. Further appeal to authority is also inappropriate if the experts in the field disagree on the point at issue. For example, if one argues in support of God's existence on the ground that Isaac Newton was a genius and he believed in the existence of God, then it will be an inappropriate appeal to authority. Even where an expert's opinion is cited who happens to be an authority on the topic, we may accept it as inductive evidence but not as deductive proof of the truth of a conclusion.

Argument Against the Person (*argumentum ad hominem*) : This fallacy occurs when a person is attacked instead of the assertion itself. One is asked to reject a proposition because the person who asserts it is in some way disreputable. This fallacy also occurs when a discussion is moved to a personal level through character assassination or personal attacks. The *ad hominem* fallacy has three major forms. These are abusive, circumstantial, and *tu quoque*. When an arguer attacks a person's character rather than the assertion made by that person, *ad hominem* (abusive) fallacy is committed. *Ad hominem* (circumstantial) fallacy is committed when instead of attacking

an assertion an arguer points to the relationship between the person making the assertion and the person's circumstances. *Ad holninem* (*tu quoque*) fallacy is an attack on the person on the ground that the person does not practice what he preaches. This fallacy is committed when someone, instead of attacking an argument, tries to refute it by saying that the arguer does the very thing he or she is arguing against. The following can be considered as examples of these fallacies.

(i) "You claim that atheists can be moral - but you claim to be an atheist and yet indulge in unfair and dishonest practices." (*ad hominem* abusive)

(ii) "You say that the Government should guarantee free elementary education for all children, but you are a publisher of text books for children and you stand to gain from this. (*ad hominem* circumstantial)

(iii) "You advise me that I should not smoke, but you are a chain smoker !" *(ad hominem tu quoque*)

Appeal to Ignorance (*argumentum ad ignorantiam*) : The fallacy occurs when it is argued that something must be true simply because it hasn't been proved false, or that something must be false because it hasn't been proved true. It assumes that since there is no evidence against a claim the claim must be true. It proposes that we accept the truth of a proposition unless an opponent can prove otherwise. But the absence of evidence against a proposition is not enough to secure its truth. This fallacy is committed in the following examples.

(i) No one has proven that ghosts do not exist, so ghosts exist.

(ii) It has not been shown that there is life on Mars. So, there is no life on Mars.

Irrelevant Conclusion (*ignoratio elenchi*) : This fallacy occurs when an arguer tries to establish the truth of an assertion by offering an argument that in fact offers support for some other conclusion. Such an argument purport to prove one thing but proves a different conclusion. Consider the following argument :

"Children should get sufficient attention from their parents. Since working parents cannot give sufficient attention to their children, mothers should not take up any job."

The argument supports some conclusion generally about working parents, but not a conclusion focused on women alone.

(b) Fallacies of Presumption :

Some arguments are fallacious because they are based on unwarranted assumptions. In these arguments the error arises out of an implicit supposition of some other proposition whose truth is uncertain or questionable. The fallacy of presumption may occur when something is assumed to be true though it is not reasonable to accept it in the relevant context.

Accident : The fallacy of accident occurs when a rule that is generally applicable is applied to an exceptional case and the exceptional character of the case is ignored. A general rule is applied when circumstances suggest that an exception to the rule should apply. This fallacy is also called the Fallacy of Ignoring the Exception. For example :

(i) The law states that one should not drive faster than 50 km per hour. Therefore, even when the road is empty and you are rushing an emergency patient to the hospital you should not drive faster than 50 km per hour.

(ii) One should return the thing one has borrowed when asked for. Therefore, you should return the pistol to its owner even when he is going to commit suicide.

There is also a Converse Fallacy of Accident. It consists in assuming that what holds true under some special circumstances must hold true as a general rule. A man who refuses to take alcohol, even when asked by the doctor, on the ground that alcohol is a poison commits the fallacy of accident. Conversely, a man has been prescribed to take alcohol when he was ill, but he reasons that it would be alright for him to continue taking it even after getting well. This man commits the converse fallacy of accident.

Begging the Question *(petitio principii)* : The fallacy of begging the question arises when the truth of the conclusion is assumed by one of the premises. To beg the question is to assume the very point at issue one is arguing for. Often, the conclusion is simply restated in the premises in a slightly different form. For instance, in the argument "Since I am not lying, it follows that I'm telling the truth" the fallacy of begging the question is obvious or explicit. However there are instances where the fallacy is not obvious. In such cases the premises of the argument implicitly assume the conclusion. Consider the following argument: "We know that gods exists, because the scriptures

say so. What the scriptures say must be true, since gods have written the scriptures". This argument begs the question because one of its premises "Gods have written the scriptures" assumes that gods exist.

It can be noticed that an argument that begs the question is formally valid. The problem here is that this valid argument does not really provide support for the truth of its conclusion. An argument that begs the question will have a premise that will not be accepted by a person who questions the truth of the argument's conclusion.

Fallacy of Complex Question : This fallacy occurs when someone demands a single answer to a complex question. This is a deceptive form of questioning, in which a single answer is demanded to what is not really a single question. This fallacy is also called the fallacy of many questions. Consider, for example, the classic example of a complex question "Have you stopped beating your wife?", in which the respondent is asked to answer in simple 'yes' or 'no'. Either answer would lead to an apparent admission of wickedness. The following are some more examples of complex questions :

"Have you stopped smoking?"

"Where are you hiding the money you have stolen?"

"What hair dye are you using?"

"How long will you interfere in our affairs?"

These are loaded questions. Each of these questions presupposes a definite answer to another question which has not been asked.

False Dilemma: This fallacy occurs when it is presumed that there are only two choices while in fact more options are available. This fallacy is also called “black and white thinking”, because it oversimplifies the options by assuming that one of the two extreme views must be true.

The following remarks can be instances of false dilemma or black and white thinking.

Either you are my friend or my enemy.

Either you love a person or hate him.

A person is either wise or a fool.

If you are not for me then you are against me.

If you love your wife, then you will surely buy this saree for her.

(c) Fallacies of Ambiguity :

Some arguments are fallacious due to imprecise use of language. When a word, phrase, or sentence is used in different senses in course of an argument this type of fallacy is committed.

Fallacy of Equivocation : This fallacy is committed when a key word or phrase is used with two or more different meanings in the same argument. The following arguments are guilty of committing this fallacy :

(i) "Since a criminal is a law breaker, a criminal lawyer too is a law breaker." It can be noticed that the term 'criminal' has been used in two different senses in the argument. A criminal lawyer is not a criminal.

(ii) The signboard says "fine for parking here". A driver notices the signboard and reasons as follows: "Since it is fine. I will park my vehicle here." This surely is a misinterpretation. The word 'fine' has been used in two different senses here. In the signboard 'fine' means penalty. But the driver thinks that it means 'all right'.

(iii) "Nature is governed by laws. Laws are the work of law makers. So, laws of nature are the work of some law maker." In this argument the term 'law' has been used ambiguously. It means descriptive law in the first premise but used in the sense of prescriptive law in the second. Only prescriptive laws are the work of law makers. Laws of nature are descriptive laws and not prescriptive.

(iv) Really exciting novels are rare. But rare books are expensive. So, really exciting novels are expensive. Here the word 'rare' is used in different ways in the two premises of the argument. In the first premise 'rare' means extraordinary, whereas in the second it means novels that are scarce.

Amphiboly : The construction of a sentence sometimes allows it to have two different meanings or interpretations. Amphiboly occurs when an arguer misinterprets a sentence that is syntactically or grammatically ambiguous and goes on to draw a conclusion on this faulty interpretation. This fallacy can also occur when someone is quoted out of context. The announcement that there will be a lecture on heart attack in the auditorium may be misinterpreted to mean that the lecture will be on heart attacks which have occurred in the auditorium. The ambiguity, however, can be clearly avoided if the phrase "in the auditorium" is placed immediately after "lecture" instead of "heart attack."

Accent : The fallacy of accent occurs when emphasis is used to suggest a meaning different from the actual content of the proposition. For examples, if a teacher remarks, "Ravi has done the homework today" with undue emphasis on 'today', that might suggest that Ravi normally comes to school without doing homework.

Fallacy of Composition : This fallacy occurs when an attribute true of the parts of something is erroneously transferred to the whole. Consider the following argument :

Each player in the team plays well.

Therefore, the whole team plays well.

This argument commits the fallacy of composition. From the fact that each individual player is a good player it doesn't follow that the whole team plays well.

Fallacy of Division : This fallacy occurs in an argument when an attribute true of a whole (or a class) is erroneously transferred to its parts (or members).
Consider the following argument :

Men are numerous.

Aristotle is a man.

Therefore, Aristotle is numerous.

The argument is fallacious. It is true that "man" as a class has many members. So the class "man" as a whole is numerous. But we cannot draw the conclusion that each individual human being is numerous.

SUMMARY

Fallacies are mistakes in reasoning. It includes both mistakes in argument and in other forms of reasoning such as definition, explanation, unwarranted assumptions. Fallacies are broadly classified as formal and informal. Formal deductive fallacies are committed whenever we violate the rules of different types of deductive inferences. On the other hand, informal fallacies take into account the content and purpose of the argument and other forms of reasoning. Informal fallacies have been broadly classified into three types namely (i) fallacy of relevance, (ii) fallacy of presumption and (iii) fallacy of ambiguity.

Fallacies of Relevance are committed when instead of citing logically relevant reasons a conclusion is defended by appealing to irrelevant reasons. The following forms of this fallacy have been discussed.

Appeal to Force: Threat or intimidation is used to make someone accept a conclusion.

Appeal to Pity: An arguer, instead of citing reasons, tries to evoke pity and sympathy.

Appeal to the People: A view is claimed to be true because most people believe it to be true.

Appeal to Authority: Appeal to authority is inappropriate when the person cited is not an expert on the subject.

Argument Against the Person: A person is attacked instead of his or her view.

Appeal to Ignorance: It is argued that something must be true, simply because it has not been proved false or that something must be false beacause it has not been proved true.

Irrelevant Conclusion: An arguer tries to establish the truth of an assertion by offering an argument that in fact offers supports for some other conclusion.

Fallacies of Presumption are based on unwarranted assumptions. The following forms of this fallacy have been discussed.

Accident: A rule that is generally applicable is applied to an exceptional case.

Converse Accident: An exception is applied where a general rule should apply.

Begging the Question: The truth of the colnclusion is assumed by the premises.

Complex Question: It is a deceptive form of questioning, in which a single answer is demanded to what is not really a single question.

False Dilemma: A limited number of options (usually two) is given, while in reality there are more options.

Fallacies of Ambiguity are due to imprecise use of languate. The following forms of this fallacy have been discussed.

Equivocation: A word or phrase is used with two or more different meaning in the same argument.

Amphiboly: It arises when the structural ambiguity of a sentence allows different interpretations.

Accent: This occurs when emphasis is used to suggest a meaning different from the actual content of the proposition.

Composition: This fallacy occurs when an attribute true of the part (or members) is mistakenly transferred to the whole (or the class).

Division: This fallacy occurs when an attribute true of the whole (or the class) is mistakenly transferred to the part (or its members).

MODEL QUESTIONS

Objective type

I. Identify in the following passages if any fallacy is committed.

1. Every part of this chair is light. Therefore, this chair is light.
2. Really exciting novels are rare. But rare books are expensive. Therefore, really exciting novels are expensive.
3. You advise me that I should not smoke but you are a chain smoker.
4. Of course there is nothing wrong with corruption. Most people think that it is acceptable.
5. Thus there is ample proof of the truth of the Bible. All those who refuse to accept that truth will burn in Hell.
6. Of course there are no extra-terrestrial living beings. Nobody has shown any proof that they exist.
7. Isaac Newton was a genius and he believed in God. So God exists.
8. We know that God exists because the Bible tells us so. And we know that the Bible is true because it is the word of God and God never lies.
9. Since I'm not lying, it follows that I'm telling the truth.
10. A car uses less petrol and causes less pollution than a bus. Therefore cars are less environmentally damaging than buses.
11. Did you apologize for your misbehaviour?
12. My parents are poor and ailing. So please give me pass mark in the subject.
13. Well, I'm going to continue to believe that there is life on Mars, and that they visit us regularly, unless you can prove otherwise!
14. Do you understand why Logic is difficult?
15. No fish is a mammal. No salmon is a mammal. So, all salmon are fish.
16. No courageous creature flies. The eagle is a courageous creature. Therefore the eagle does not fly.

17. Three and five are odd numbers. Eight is three and five. Therefore, eight is an odd number.
18. Since it is true that some Odias are not entrepreneurs, it follows that some entrepreneurs are not Odias.

II. Fill in the blanks by choosing the correct word or phrase from the options given in the bracket.

1. When the question asked presupposes the truth of a claim hidden in that question, the fallacy of _____ is committed. (presumption, ambiguity, relevance)
2. When an argument uses a premise which appears to provide support, but is not logically connected to the conclusion, the fallacy of _____ is committed. (relevance, presumption, ambiguity)
3. When we confuse two or more meanings of a word or phrase in the context of an argument we commit the fallacy of _____. (relevance, presumption, ambiguity)
4. The fallacy of _____ ad hominem is present whenever an insulting remark is used in place of a reason in an argument. (abusive, circumstantial, tu qouque,)
5. When one assumes the truth of the very point one is set out to prove, one commits the fallacy of _____. (begging the question, ignoratio elenchi, converse accident)
6. The argumentum ad _____ is the mistake of arguing that a proposition is true simply because it has not been proved false, or that it is false because it has not been proved true. (ignoratiam, verecundiam, hominem)
7. The argumentum ad _____ occurs when the appeal is made to someone having no legitimate claim to authority in the matter at hand. (verecundiam, hominem, ignoratiam)
8. When a general rule is applied to individual cases that it does not correctly govern, the fallacy of _____ is committed. (accident, division, composition)
9. The fallacy of _____ occurs when one argues that what is true of parts of a whole is true of the whole itself. (accident, division, composition)
10. The fallacy of _____ occurs when one argues that what is true of the whole is also true of its parts. (accident, division, composition)

III. Point out in each case whether the statement is true or false

1. Fallacies are errors in reasoning.
2. The fallacy of relevance occurs where a conclusion is defended by invoking irrelevant reasons.
3. "If P then Q. Not-P. Therefore, not-Q." This is a valid form of deductive argument.
4. If someone argues "since no argument for the existence of God is sound, God does not exist", it would be a case of the fallacy of appeal to ignorance.
5. Ad hominem fallacy consists in attacking the character of the opponent instead of refuting the argument.
6. When a question is very complicated, we call it the fallacy of complex question.
7. The fallacy of amphiboly occurs when something is taken out of context and is thus misconstrued.
8. We commit the fallacy of accent whenever we use a sarcastic tone to give our words a meaning quite different from their literal sense.

Essay-type Questions:

1. Explain and illustrate the distinction between fallacies of composition and division.
2. Distinguish between fallacies of accident and converse accident. Explain the difference with examples.
3. Explain with examples the different types of fallacy of ambiguity.
4. Discuss the various forms of fallacy of relevance.
5. Explain the different forms of the fallacy of presumption.

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CHAPTER-6
MILL'S METHODS OF EXPERIMENTAL INQUIRY

6.0 MILL'S EXPERIMENTAL METHODS

Nature is complex and complicated. To discover the cause of a phenomenon is not that easy a matter. It requires at times great acumen and effort to find out the cause of an event. But the question is-what method should be adopted to find out the cause of an event! Different methods have been suggested which are used in the process of scientific explanation to discover the cause of a phenomenon. Such methods are called the experimental methods.

But before the real cause of an event is known the irrelevant factors need to be eliminated. The non-essential antecedents should be rejected so that it would pave the way to discover the real cause of a phenomenon. Francis Bacon has suggested some methods that can enable to reject the unnecessary antecedents from the fold of the supposed cause. They are:

1. An absent circumstance cannot be the cause.
2. A circumstance in whose presence the phenomenon (effect) does not occur cannot be the cause.
3. The cause and the effect vary together and the variations are proportional.

J. S. Mill later on made some revision and addition in these versions of Bacon and explained the principles of elimination. A principle of elimination helps reject the unnecessary antecedents in a complex situation so that it would be easier to imagine the cause. These principles of elimination are:

1. Whatever antecedent can be left out without prejudice to the effect can be no part of the cause
2. When an antecedent cannot be left out without the consequent disappearing such antecedent must be the cause or a part of the cause.
3. An antecedent and a consequent rising and falling together in numerical concomitance are to be held as cause and effect.
4. Nothing is the cause of a phenomenon, which is known to be cause of a different phenomenon. (Joseph)

Basing on these above mentioned principles of elimination there are five experimental methods which have come to be known as **"Mill's methods of inductive inference"**. Mill has formulated five "Canons" or experimental methods for establishing causal connection.

The experimental methods are named as follows:-

1. The method of Agreement.
2. The method of Difference.
3. The joint method of Agreement and Difference.
4. The method of Concomitant Variation.
5. The method of Residues.

The different methods make use of the different principles of elimination. For instance the method of Agreement makes use of the first principle of elimination, the method of Difference makes use of the second principle, the method of Concomitant Variation makes use of the third principle and the method of Residues makes use of the fourth principle. The joint method of Agreement and Difference being a modification of the method of Agreement and Difference makes use of either or both the first principle and the second principle of elimination. Now let us turn to the methods for elaborate discussion.

6.1 THE METHOD OF AGREEMENT:

J. S. Mill's Canon: If two or more instances of the phenomenon under investigation have only one circumstance in common, the circumstance in which alone all the instances agree, is the cause (or effect) of the given phenomenon.

The importance of this method as compared to the procedure, of simple enumeration, is that it seeks to identify the one and the only circumstance that is associated with the effect. It is not the observation of merely the conjunction of one phenomenon with another phenomenon for a number of times.

There is the need of examining the constituent factors involved with the instance about which a causal connection is suspected. Among the antecedent factors and the consequent factors the presence of the single invariable factor is taken into account for the causal relationship.

Obviously there is the need of more than two instances where the event occurs. In all those cases there should be only one circumstance common both in the antecedent and consequent side. For example, if it is noticed that in a village the villagers have become able to get very good crops and they all have used a definite type of fertilizer for their cultivation then the causal connection between the two events may be thought of. Here one can notice the agreement between using a particular fertilizer and getting good crops and on that basis of agreement the causal connection between the pair of events may be established.

Similarly noticing the presence of large number of coconut trees in the sea areas, one can draw the conclusion that climate nearer to the sea is suitable for the better growth of coconut trees.

Symbolically the method of Agreement may be represented as:

A B C M followed by X Y Z P

A C D G followed by X Z S T

A E F D followed by X N R S

A and X are causally related.

In the above example in the antecedent side A is common to all three cases. B is absent in the 2nd and 3rd instances, C is absent in the 3rd instance, D is absent in the 1st instance, E and F are absent in the 1st and 2nd instances, M is absent in two other instances. So the three instances agree in respect of the occurrence of A in the antecedent side. Similarly X is common to all the three instances of consequent side. On this agreement it can be said that A is either the cause or a part of the cause of X.

This method is based on the first principle of elimination i.e. "whatever antecedent can be left out without prejudice to the effect can be no part of the cause". The significance of this principle is that if after taking away some circumstance still the effect is present then that circumstance cannot be the cause. In other words a circumstar in the absence of which the effect occurs cannot be the cause. Basing on this principle B, C, M, G, E, F, D cannot be the cause.

Let us take some concrete example. By reading the books published by the Bureau of Textbook Preparation if a number of students achieve success in examinations, other conditions remaining variable, it will be presumed that the success of students may be due to their reading of the books of the Bureau of Textbook Preparation.

From a dental survey it was seen that in some particular cities the dental decay was remarkably low. After further investigation it was found that in their water supplies there was high level of fluoride. Thus it was supposed that the use of fluoride water is causally connected with the decrease of dental decay.

6.1.1 CHARACTERISTICS

1. It is a method of single agreement. Mellone and Coffey call this method as the method of single agreement. Here there is agreement in one circumstance only. Other circumstances differ in the instances. In the case of more than one agreement this method is ineffective. The singleness of the agreement gives the impression of a causal relation.

2. It is a method of observation. Through the observation of a number of instances where the common factor of agreement is found the causal connection can be established. It is primarily a method of observation. But it does not mean that it is not applicable to experimental cases.

3. It is a method of discovery rather than a method of proof. Observation is a guide to discover something rather than to prove something. Since the method is a method of observation; it is a method of discovery. Through this method a causal connection is discovered between two phenomena because of their simultaneous occurrences. When two phenomena occur simultaneously it gives the impression that there might be a causal link between them.

6.1.2 ADVANTAGES OR MERITS OF THE METHOD :

1. The method of agreement is applicable in a wide range of cases. As the range of application of observation is much wider compared to that of experiments, the method of agreement too has a wide sphere of application, since the method is based on observation.

2. The method of agreement is applicable to find out the causal connections from both the directions. It can proceed from cause to effect as well as from effect to cause of a phenomenon.

6.1.3 DISADVANTAGES OR DEMERITS OF THE METHOD:

1. Characteristic Imperfection: This method fails to establish causal connection in the case of plurality of causes.The doctrine of plurality of causes is not an unchallengable doctrine. But there are certain cases of observations where the factor responsible for the occurrence of the effect may differ and the notion of plurality of causes somewhat becomes acceptable because of uncritical and simple observations.

For example, in some cases where people have suffered from headache and have taken medicines bearing different names like Saridon, Aspirin, Oxalgin, Nise, etc. all of them have taken the medicine with water. All of them have got relief from headache. Since the medicines differ from case to case but water is the common factor, as per this method the common factor water will be treated as the cause of relief from headache, which is not the case. Uncritical observation can assume an accidental factor to be the cause.

2. Practical imperfection: When the fallacy of non-observation is committed in respect of this method, it becomes a disadvantage for the application of this method. There can never be any guarantee that all the factors involved with the occurrence of the incident are observed. It may so happen that some of the essential circumstances may remain unobserved. This defect is known as practical imperfection of the method. Instead of taking few instances if the observation of instances are increased, then there is the possibility of overcoming such a defect. But this method may not be able to help in all the cases. For example, the scientists, so far, have failed to find out the common factor of agreement in case of diseases like cancer where there is unusual cell-division. The common factor responsible for the unusual cell-division is not yet properly known. Because of the complexicity of nature it is not possible to know the cause of a phenomenon by observation.

3. It is not possible to distinguish cause from co-existence by this method. Just like the causal factor is found common in a number of cases so also the factors which co-exist are also found in common in a number of cases. Because of common agreement a factor which is commonly found as co-existing may be considered as cause on the same ground. The lightning co-exists with thunder so one may think of a causal connection between them. Lightning co-exists with thunder but is not its cause. Both as them are the effects of some cause. Observation fails to separate coexistence from cause.

4. A condition or a part of a cause may be found as a common antecedent in a number of

cases. In such cases that condition may be supposed as the cause because of the agreement in a number of cases. For example, the requirement of sour for the preparation of curd agrees in most of the cases. Sour is one of the conditions of curd but not the whole cause. Here there is every chance of confusing a condition to be the cause.

5. The applicability of this method fails in the case of conjunction of causes and intermixture of effects.

This method will not be useful to isolate the exact antecedent in case of conjunction of causes. This method takes for granted that antecedents and consequents are distinguishable. But this is not really the case. For in some cases a joint effect may be the outcome of some conjunction of individual causes where it is not possible to isolate the effect of a particular antecedent.

Because of the above defects it is never possible to reach at a conclusive causal connection through this method. It is always better to accept that this method can suggest a hypothesis, which is highly probable. So the causal connection established through this method is only probable in nature.

6.2 THE METHOD OF DIFFERENCE :

MILL'S CANON:

"If an instance in which the phenomenon under investigation occurs and an instance in which it does not occur have every circumstance in common save one, that one occurring only in the former; the circumstance in which alone two instances differ is the effect or the cause or an indispensable part of the cause of the phenomenon".

Mill has considered this method to be quite dependable for ascertaining causal connections. To him it can prove the causal connection beyond doubt. The importance of this method lies in the fact of taking only two instances for the purpose of investigation for establishing the causal connection. Mill considers the method to be the method per excellence.

Mill has narrated the case of a man who died just after the gunshot. The point of single difference between the two instances (i.e. before the gunshot and after the gunshot) is that the death followed gunshot. This is an example of the method of difference.

Symbolically the method of difference may be represented as:

A B C D are followed by WXYZ

B C D are followed by XYZ

∴ A is the cause or part of the cause of W

OR

B C D are followed by X Y Z

A B C D are followed by W X Y Z

∴ A is the cause of W

In the two above examples the single factor of difference is either A is added to or excluded from the existing antecedent factors and there is the corresponding addition or exclusion of W in the instances of the consequent respectively. So A is causally connected with W.

This method is based on the principle of elimination that; "when an antecedent cannot be left out without the consequent disappearing, such antecedent must be the cause or at least a part of the cause". The significance of this principle is that if after taking away some antecedent condition from the circumstance some effect also goes away, then they are considered to be causally related. The basis is "a circumstance in whose presence the phenomenon does not occur cannot be the cause".

CONCRETE EXAMPLE:

1. In the presence of the light the things of the room are visible. In the absence of the light the things are not visible. Hence the presence of the light is causally connected with visibility of things.

2. The coffee was not tasty when sugar was not added to it. It became tasty after the addition of sugar. So sugar is causally connected with better taste.

6.2.1 CHARACTERISTICS OF THE METHOD OF DIFFERENCE:

1. It is a method of single difference. Mellone and Coffey approve this name in respect of this method. Since only two instances are required here, the singleness of difference forms the basis of ascertaining a causal relation between two phenomena.

2. It is mainly a method of experiment. Here there is the artificial reproduction of an event to test the causal relation. The instances chosen are of a special nature. The conditions are identical in all respect except in one. By experiment we isolate a condition and see the outcome or we introduce a condition and observe the effect. Since it is done under controlled conditions it becomes easier to ascertain a causal connection between two phenomena.

3. It is a method of proof. Since the causal connection is established through experiments, it is a method of proof.

6.2.2 ADVANTAGES OF THE METHOD:

1. It needs only two instances, though of a very special type. It is therefore comparatively easier to investigate the causal connection between two phenomena. Of course selecting the two phenomena to be investigated requires special ability on the part of the experimenter.

2. The result obtained by applying the method is conclusive in ascertaining a causal connection. Whatever is experimentally proved seems to be very much dependable.

3. Usually this method is applied to confirm a hypothesis. The method of agreement mostly suggest a hypothesis to explain a phenomenon. This hypothesis is put under repeated test by the method of difference either to be accepted or to be rejected. To test a hypothesis this method is resorted to in many cases.

6.2.3 DISADVANTAGES:

1. The method fails in the case of plurality of causes. This method proves a cause but that may not be the cause. A case of fever may be cured by the application of cinarest in some case. But it is not the only medicine for the cure of the cases of fever. In another case the fever may be cured by the application of bryonia (Homeopathic medicine). So the application of cinarest cannot be considered as the sole cause of cure. Thus the method fails to overcome the difficulty that is caused by the plurality of causes.

2. There is the possibility of committing the fallacy of *Post hoc ergo propter hoc which means* "after this therefore, due to this". It is a case where some event happens after some event. The event that occurs first is considered as the cause of the later event just because it has occurred prior to the other one. In this case there is possibility of committing the fallacy for it may be a chance coincidence. When an accidental antecedent is considered as the cause it becomes fallacious.

   A political leader dies after the appearance of a comet. If the appearance of the comet will be considered as the cause of the death of the leader there will arise the fallacy of post hoc ergo propter hoc.

3. A condition suitable for the production of the effect may be considered as the cause by this method. That means through this method one cannot distinguish between a condition and a cause. A condition is mostly the indispensable part of the cause. While noticing the single difference one may notice the condition but not the entire causal factor. For example, with a new Managing Director a company may flourish to a great extent. But joining of the new MD is one of the conditions for that effect. The factors like the co-operation of other staffs, sincerity of the employees etc. are equally important for that effect. If some one takes note of the single difference and considers that factor to be the sole cause, there he confuses between the cause and the condition.

4. It is primarily a method of experiment. In case of experiments the sequence of occur-

rence of events as cause and effect cannot be altered. So it is not possible to proceed from effect to cause by the help of this method. This shows that the applicability of the method is limited as compared to the method of agreement which is based on observation.

5. The method is not applicable in case of permanent causes. There are certain factors like temperature, atomospheric pressure, magnetic influence, gravitational force, etc., which remain constantly present. Unless extraordinary arrangements are done to avoid them, they cannot be done away with. Their constant presence is treated as permanent and if any of them is the indispensable part of the cause, then it is treated as the permanent cause. As per the procedure of the method the differential factor should be present in one instance and be absent in the other instance. Since where the cause is a permanent one and it cannot remain absent with the event it is causally connected, the method of difference is not applicable in such cases.

6.3 THE JOINT METHOD OF AGREEMENT AND DIFFERENCE:

Mill's Canon:

"If two or more instances in which the phenomenon occurs have only one circumstance in common, while two or more instances in which it does not occur have nothing in common save the absence of that circumstance, the circumstance in which alone the two sets of instances differ is the effect or the cause, or an indispensable part of the cause of the phenomenon".

The importance of this method is that the causal connection is determined on the basis of double agreements i.e., the agreement in presence and agreement in absence. Hence for this method there is the need of two sets of instances. For example, suppose in a village by using a particular fertilizer people get good harvest and in the neighboring village, people have not used that fertilizer and have not got good harvest then the causal connection between two incidents namely using the fertilizer and getting good harvest can be supposed. Thus where the

presence of one incident leads to the occurrence of another incident and the absence of that incident leads to the absence of the other incident a causal connection between the two phenomena can be suggested. Because of the double agreement i.e. agreement in presence and the agreement in absence the causal connection can be ascertained with higher probability. The following example will illustrate it.

Symbolical example:- Positive Set

A B C are followed by abc

A B D are followed by abd

∴ A C D are followed by acd

AND **Negative Set**

B C D are followed by bcd

C D E are followed by cde

B E F are followed by bef

∴ A and a are causally related.

In this example among the positive instances A is common to all the three antecedent instances and correspondingly a is common in the three consequent instances. Moreover, among the negative instances A is absent in the three antecedent instances and correspondingly a is absent in the consequent instances. Here a causal connection between A and a is accepted.

This method is based on both the first and second principle of elimination. It follows that whatever is absent in presence of a phenomenon cannot be the cause of that phenomenon and a circumstance in whose presence the effect does not occur cannot be the cause. Basing on these principles. B, C, M, G, E, F, D cannot be the cause.They are taken as accidental conditions and are rejected in the process of ascertaining the cause.

CONCRETE EXAMPLE:

1. In the cricket matches where Saurav is captain of the Indian team, the team wins and when Saurav is absent the term loses. Other circumstances being the same the captainship of Saurav is the cause of the winning of the team.

2. The students who follow the textbooks regularly get good marks. The students who do not follow the textbooks but follow notebooks do not get good marks. Other conditions remaining almost the same it follows that following textbooks and securing good marks are causally connected.

6.3.1 CHARACTERISTICS:

1. In the joint method there is application of the method of agreement and the method of difference. Hence the principles of elimination of both these methods are applied in this method to eliminate the accidental factors and to find out the real cause. Whatever antecedent can be left out without affecting the effect cannot be the cause. Similarly what cannot be eliminated without affecting the phenomenon must be causally related with it.

2. It is not a primary method. It is the modification of the method of agreement and the method of difference. Fowler calls this method "the double method of agreement" and Bain calls it "the method of double agreement".

   But Mill considers this method as a special modification of the method of difference and calls it, "the indirect method of difference". Venn considers this method as the method of exclusion.

3. In the method of difference only two instances are taken into consideration whereas in the joint method two sets of instances are taken into consideration. The method of difference strictly adopts experiment for finding out the instances but in the joint method instances may be collected either by experiment or by observation.

4. The joint method proves the causal relation in an indirect way. The method of agreement suggests a causal relation through the positive set and the joint method confirms the suggestion through another set, the negative set. Hence it is supposed to be the method of proof.

6.3.2 ADVANTAGES OR MERITS OF THE METHOD:

1. It is a dependable method because it proves the supposition obtained through the method of agreement. The method becomes more dependable if the instances are chosen carefully.

2. This method can be applied to the cases of observation and also to the cases of experiment. When the instances are taken from observations it becomes a modification of the method of agreement and when the experimental instances are taken into consideration it becomes a modification of the method of difference.

3. It has a wide range of application. The cases of plurality of causes cannot create difficulty for this method. For it considers the negative instances that help to avoid the unconnected common antecedent.

6.3.3 DISADVANTAGES:

1. Mill claims that this method eliminaties the difficulties arising out of the plurality of causes. The method of agreement is unable to tackle it.

   Some logicians point out that the possibility of plurality of causes is not agreeably eliminated by this method. Because the particular agreeable factor may be the cause so far. But there may remain many other cases unexamined where the cause may be different. So this method does not fare better to tackle the problem arising out of plurality of causes.

2. This method also fails in case of intermixture of effects. The method can be applied when the antecedents and the consequents are distinguishable in conjunction of causes and intermixture of effects. But if the consequents make a complex phenomenon it is not possible to apply the joint method.

3. The joint method is of no value in case of permanent causes. For it is not possible to procure negative instances.

4. It also fails to distinguish the cause from co-existence. Because in respect of the co-

existence of incidents two phenomena may be present or absent in several instances. But they may not be causally related. Lightning always precedes thunder and they are also absent together. But lightning is not the cause of thunder, but they are the co-effects of some other cause.

6.4 THE METHOD OF CONCOMITANT VARIATION:

MILL'S CANON:

"Whatever phenomenon varies in any manner whenever another 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".

Mill has considered the method of difference to be the 'method par excellence'. But Mill's opinion regarding the method of difference may be considered as mistaken if we compare that method with the method of concomitant variation. In case of the method of concomitant variation there is variation of one factor in respect of degree or quantity. This variation in respect of a single factor in a number of cases leads to some authentic causal relation. Hence this method may be graded as the method par excellence.

Symbolical Example:

(i) A_1, B C are follwed by x_1 y z

A_2 B C are follwed by x_2 y z

A_3 B C are follwed by x_3 y z

$\therefore$ A is the cause of x

OR (ii) A_1, B C are followed by x_1 y z

A_2 C D are followed by x_2 z w

A_3 E F are followed by x_3 p q

$\therefore$ A and x are casually related

In the above examples A varies from instance to instance in the antecedent side and correspondingly x also varies from instance to instance in the consequent side. In the symbolic example (i), while the accompanying circumstances remain the same, BC in the antecedent side and yz in the consequent side, in the symbolic example. (ii) the accompanying characteristics change from instance to instance. But in both the examples when the antecedent 'A' quantitatively changes corresponding changes occur in the consequent 'x' whether the accompanying circumstances remain the same or not. The variation between A and x suggests a possible causal relation between them. Thus depending upon this single variation a causal connection between A and x is established.

Here the third principle of elimination is followed. That is "an antecedent and a consequent rising and falling together in numerical concomitance are to be held as cause and effect". It amounts to saying that when the causal factor varies in any manner the effect factor also varies in some particular manner. The cause and effect vary together with a definite proportion.

CONCRETE EXAMPLE

1. When the rate of gold increases it is also seen that the sale of gold decreases. This shows that the increase of rate and the decrease in the sale are causally related.

2. When there is increases of temperature in the body there is also increase of mercury level in the thermometer. This variation shows that heat and increase of the mercury level (expansion of mercury) are causally connected.

3. The variable relation between the size and position of the moon and the rise and fall of tides in the sea is shown as the example of this method Mill. When there is increase of the size of the moon on the sky the rise of tide increases in the sea. When there is decrease of the size of the moon, the rise of tides falls. Thus the two factors are causally related.

6.4.1 CHARACTERISTICS

1. The method of concomitant variation is not a primary method for it is either a modification of the method of agreement or a modification of the method of difference. When the accompanying circumstances are the same in all the instances, it is a modification of the method of difference. On the other hand when the accompanying circumstances are different in the instances, the method is a modification of the method of agreement.

2. This method is founded on the quantitative aspect of causation. The cases of quantitative variations can be taken into account for deciding the causal relation. Sometimes the method is called a statistical method as it can be expressed graphically.

3. It is primarily a method of discovery but it is also quite helpful incase of scientific investigations. So it is both a method of observation and experiment.When the method is a amodification of the method of agreement, it is based on observation. When the method is a modification of the method of difference, it is based on experiment.

6.4.2 ADVANTAGES:

1. The significant advantage of this method is that in case of inseparable homogenous intermixture of effects this method is very much helpful. By the application of quantitative variation to any particular factor the causal connection can be determined.

2. This method is also helpful in case of permanent causes. The permanent causes cannot be dropped. But they can be increased or decreased. In this way the principle of variation is applicable to it. This method is specially applicable in case of permanent causes.

3. The result obtained by this method is highly reliable especially when it is applied experimentally.

6.4.3 DISADVANTAGES:

1. It is a quantitative method. It is not applicable in case of qualitative variations.

2. This method is applicable in case of quantitative variations, but up to a certain limit. The quantitative variation cannot be applied after a particular limit.

3. A proportional variation may also be possible in the instances of co-existences. In such cases the method is unable to distinguish between the cause and co-existence. We have experienced proportional variation of time span of the day and night. It is an instance of co-existence. But one may confuse it as a causal instance attaching emphasis on the factor of variation.

4. A condition may vary proportionately. In such case this method is unable to distinguish between the cause and the condition.

5. This method is not applicable in case of plurality of causes. Because this method relies only on a case of single variation.

6.5 THE METHOD OF RESIDUES:

MILL'S CANON:

"Subduct from any given phenomenon such part as is known by previous induction to be the effect of certain antecedents and the residue of the phenomenon is the effect of the remaining antecedents".

The significance of this method is that this method is applied in the complex cases. It is applied only in such complex cases where the causal relationship of the contained factors are known excluding one. Only in such cases the causal relationship between the remaining factors are established.

SYMBOLICAL EXAMPLE:

ABC is followed by xyz

BC is known to be casually connected with yz

$\therefore$ A is the cause of x

This method applies the new principle of elimination added by Joseph. It follows the principle, nothing is the cause of a phenomenon which is known to be the cause of a different phenomenon. In the above example since y and z are known to be related to B and C, y and z cannot be causally connected with A. Hence the remaining one x is causally connected with A.

CONCRETE EXAMPLES:

1. The cost of three articles A, B and C is Rs. 100/-. It is known that the cost of B is Rs. 35/ - and C is Rs. 25/-. It is obvious that the cost of A is Rs. 40/- which is the subduct of B and C from ABC.

2. A shopkeeper wants to know the weight of the oil in a container. He weighs it and from that weight deducts the weight of the empty container. That helps him to determine the weight of the oil.

6.5.1 CHARACTERISTICS:

1. This method is said to be a method of discovery. In a complex situation when some part of the phenomenon is not explained by the known causes this method may help to find out a further cause to explain the whole phenomenon. Mellone says that it is a "Finger post of the unexplained".

   Argon, a gas, was discovered by help of this method. When nitrogen gas collected from the atmosphere was found heavier than the nitrogen prepared in the laboratory, it was assumed that some gas might be mixed up with atmospheric nitrogen and by this method argon was discovered.

2. It is considered as the modification of the method of difference. Because both the methods employ only two instances. But this view does not seem to be proper for the reason that the method of residues is a deductive method but the method of difference cannot be considered as a deductive method. Method of difference obtains the negative instance by observation or experiment, as the case may be, but the method of residues obtains the negative instance by prior induction.

3. The method of residues is essentially a method of deduction. One can clearly notice in this case that the knowledge obtained is deducted from the total observational knowledge in order to get the conclusion. One only follows a method of deduction to reach at the conclusion. In the symbolical example we have deducted BC and xy from ABC and xyz respectively to get the relation between A and x. For this reason it is considered as a deductive method.

   Since we adopt the method of substraction, it is claimed to be a deductive method. But primarily it is an induction because the method of substraction is applied only to the cases of two observational instances.

4. The method of residues holds good only when there is some prior knowledge of causation. In no other method of experimental inquiry there is the essential need of some prior causal knowledge. Along with the previous knowledge if something more is found as unexplained, it takes the shape of a hypothesis. An attempt to explain this unexplained factor leads to the application of this method. Thus this method holds good only when there is some prior knowledge of causation.

   There was the knowledge about the path of movement of Uranus. But when Uranus was found to deviate from its calculated path, the cause of the deviation was suspected and the hypothesis was framed that the deviation might be due to some other planet. Infact, it helped in the discovery of the planet Neptune in this manner. It is considered as the application of the method of residues for the reason that the effect of the known planet was deducted from the total effect of gravitational pull of Uranus. The trial to solve the hypothesis helped to find out the causal relationship.

6.5.2 ADVANTAGES:

1. This method is used in advanced stage of scientific analysis. When in scientific analysis the data are collected by experiment the method of residues helps in ascertaining a causal relationship between two phenomena.
2. It follows the method of experiment. So its finding is highly probable. It has the advantages of experiment.
3. It can deal with complex phenomena. Especially the method is useful in case of intermixture of effects.

6.5.3 DISADVANTAGES:

1. Without previous knowledge of causal relation the method of residues cannot be applied. In absence of prior knowledge, this method canot be of any use.
2. If the complex effect cannot be reduced or analyzed, then this method cannot be applied. Especially in case of heteropathic intermixture of effects, the complex effect is due to the combination of different conditions. In the cited symbolic example, when ABC gives rise to xyz, even if the separate effect of B and C is known, we cannot ascertain the cause of xyz. The effect of B and C as independent causes may be fully different from the complex effect as the complex effect is qualitatively separate from their indivisual effects.

3. This method may confuse an irrelevant factor to be the cause. Suppose some body conducts a study on ten workers of a factory out of which five drink and five do not drink wine. Suppose it is found that in an average those who drink showed more efficiency in a month than those who do not drink. From this it will not be correct to assume that habit of drinking is the cause of increase in efficiency. By accident somebody drinks and is efficient in work.

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SUMMARY

Bacon and Mill have suggested five different methods in order to arrive at a causal connection. These are called methods of experimental inquiry. The basic procedure adopted in the methods is that through certain principles of elimination the irrelevant factors are eliminated either to prove or discover a causal connection between two phenomena.

Mill's experimental methods are:

The method of agreement

The method of difference.

The joint method agreement and difference.

The method of concomitant variation.

The method of residues.

THE METHOD OF AGREEMENT:

When a single factor of agreement is noticed between two sets of circumstances in a number of cases, that factor of agreement leads to establish a causal connection.

It is a method of observation.

It is a method discovery rather than proof.

It is a method of single agreement.

It has wider range of application.

In this procedure one can proceed from cause to effect and effect to cause.

This method is not helpful in case of plurality of causes.

One may commit the fallacy of non-observation in this method.

This method fails to distinguish between cause and condition and also between cause and co-effect.

This method is not helpful in case of conjunction of causes and inter mixture of effects.

The conclusion drawn through this method is always probable.

THE METHOD OF DIFFERENCE:

Among two instances if there is a single factor of difference the differential factors may be causally connected.

It is a method of experiment.

It is a method of proof.

It is a method of single difference.

It requires only two instances.

Causal connection established through this method has a higher degree of probability.

In this method the fallacy of post hoc ergo propter hoc is liable to be committed.

In this method we cannot pass from effect to cause.

This method fails to distinguish cause from condition.

This method fails in case of permanent cause.

This method is not applicable in case of a complex event, which is beyond our control.

THE JOINT METHOD OF AGREEMENT AND DIFFERENCE.

Between two states of instances (one positive other negative) if any two factors agree in presence in positive instances and also agree in absence in negative instances then the two may be causally connected.

It is primarily a method of observation.

It is a method of proof.

It is a method of double agreement.

The result of this method is more probable.

It is not free from the difficulty of plurality of causes.

It fails to distinguish between cause and co-existence and cause from co-effect.

It cannot be applied in case of permanent causes or conjunction of causes and intermixture of effects.

THE METHOD OF CONCOMITANT VARIATION:

It two phenomena vary together in a number of instances then they may be causally connected.

It is a modification of either the method of agreement or the method of difference.

This method is based on the quantitative aspect of causation.

The method is sometimes called a graphic method.

It is helpful in case of permanent causes.

Here the conclusion is more probable.

This method is helpful in case of intermixture of effects.

This method is applicable up to a certain limit but not beyond that.

This method fails to distinguish between cause and condition.

THE METHOD OF RESIDUES.

In case of a complex instance if the causal connection of certain factors is known, then the remaining factors may be considered as causally connected.

It is a method of discovery.

It is a modification of the method of difference.

It is essentially a method of deduction.

It is helpful in case of complex events.

It is not helpful in case of plurality of causes.

This method fails when previous knowledge of causation is lacking.

MODEL QUESTIONS

GROUP – A

Objective questions:

Method of Agreement:-

1.i. Which method is said to be a method of single agreement?

ii. Why is the method of agreement called a method of discovery?

iii. Point out one of the disadvantages of the method of agreement.

iv. Is the method of agreement based on observation or experiment?

v. What is the principles of elimination that the method of agreement applies?

2. Fill in the blanks:-

i. The method of agreement fails to distinguish cause from _____.

ii. Cause and co-existence cannot be distinguished in the method of _____.

iii. The method of agreement has a wide range as it is a method of _____.

iv. By the method of the _____ cause or the effect of a phenomenon can be discovered.

3. Method of Difference:-

I Which method is known as the method of single difference?

ii. Name the method that proves the causal relation.

iii. Give a symbolic example of the method of difference.

iv. Can the method of difference proceed from effect to cause?

v. Which method requires only two instances for asserting the causal relation?

4. Fill in the blanks:-

i. The method of difference cannot be applied in case of _____ causes.

ii. The method of _____ is primarily a method of experiment.

iii. The method of _____ is said to be a method of proof in case of experimental observation.

iv. The method of difference requires only _____ instances, though of a special type to ascertain the causal relation.

5. The Joint Method of Agreement and Difference

i. Is the joint method a primary method?

ii. Is the joint method a method of proof?

iii. Why has the joint method a wide range of application?

iv. Does the joint method overcome the difficulty arising out of plurality of causes?

v. Give a concrete example of the joint method.

6. Fill in the blanks:-

i. _____ method is considered to be a modification of method of agreement and method of difference.

ii. _____ method is not useful in case of intermixture of effects.

iii. The joint method cannot be applied in case of _____ causes.

iv. The joint method is considered to be a method of _____.

7. Concomitant Variation:

i. Give a symbolic example of the method of concomitant variation.

ii. Which method is applicable in case of permanent causes ?

iii. Point out one of the disadvantages of the method of concomitant variation.

iv. What is the principle of elimination applied in concomitant variation ?

v. Is concomitant variation a primary method ?

8. Fill in the blanks :-

i. Method of concomitant variation is not applicable in case of _____ variation.

ii. When the accompanying circumstances are different the method of concomitant variation is a modification of the method of _____.

iii. _____ method is called a graphic method.

iv. The method of concomitant variation depends on the _____ aspect of causation.

9. The Method of Residues:

i. Give a symbolic example of the method of residues.

ii. Is the method of residues a method of proof ?

iii. Is the method of residues essentially a method of deduction?

iv. Give one of the advantages of the method of residues.

10. Fill in the blanks:-

i. _____ is essentially a method of deduction.

ii. The method of residues is a special modification of the method of _____.

iii. Without prior progress in the knowledge of causation _____ method is not applicable.

iv. _____ is mostly useful in case of complex effect.

GROUP – B

Short-type Questions :

11. Answer the following:-

i. Why are the experimental methods called the methods of elimination ?

ii. Why are the experimental methods called inductive method ?

iii. Which of the experimental methods are based on observation ?

iv. Which of the experimental methods are called the primary methods ?

v. Which of the experimental methods are based on experiment ?

vi. Name the characteristic feature of all the experimental methods on the questions of discovering or proving a causal connection.

vii. What is the principle of elimination applied by the method of agreement ?

viii. What is the principle of elimination applied by the method of difference ?

ix. What is the principle of elimination used in case of concomitant variation ?

x. Name the experimental methods, which are likely to be frustrated by plurality of causes?

xi. Which of the experimental methods are not fundamental and why?

12. Explain the following:

i. Explain the characteristic imperfection of the method of agreement.

ii. Discusses how the method of agreement is frustrated by the doctrine of plurality of causes.

iii. State why the method of difference cannot be applied in case of permanent causes.

iv. Explain why the scope of the method of difference is limited.

v. How can the joint method be applied in permanent causes?

vi. Why is the conclusion arrived at by the joint method more dependable?

vii. How can the method of concomitant variation be a modification of the method of agreement and difference?

viii. How can the method of concomitant variation be a graphic method ?

ix. Is the method of residues essentially a method of deduction? Explain.

x. How is the method of residues considered a modification of method of difference?

GROUP –C

Long type Questions :

1. State and explain the method of agreement.

2. Discuss the advantages and disadvantages of the method of agreement.

3. State and illustrate the method of difference.

4. Discuss the advantages and disadvantages of the method of difference.

5. State and explain the joint method of agreement and difference.

6. Elaborate the advantages and the dis-advantages of the joint method of agreement and difference.

7. Discuss the method of concomitant variation.

8. Illustrate the advantages and disadvantages of the method of concomitant vairation.

9. State and illustrate the method of residues.

10. What is the special feature of the method of residues?

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CHAPTER – 7
SCIENTIFIC ORDER, SYSTEM AND EXPLANATION

7.1 WHAT IS SCIENCE?

Science as an intellectual enterprise has greatly contributed to human society and culture. Its development and applications have very much benefited human society. Particularly modern science and technology have changed almost all aspects of our lives. "Science" and "Scientific" are very commonly used terms of our discourse. But the terms are not used univocally and it is difficult to bring out their exact connotations. So conceptual clarity about the terms "science" and "scientific" will help us to understand the idea of scientific order, system and explanation.

The term science is sometimes used in a broad sense to mean any systematic body of knowledge. Sometimes it is also used in a narrow sense to mean an experimental study. In the broad sense if science would be taken to mean systematic body of knowledge then many non-empirical disciplines would be included in the scope of science. In this sense mathematics, ethics, aesthetics, logic will be called as science for in each of these branches of intellectual enterprise there is systematic body of knowledge. Mathematics is termed as formal science in which from limited axioms and definitions theorems are deductively deduced. Ethics, aesthetics are termed as normative sciences for they are goal-oriented. They fix up some idea or norm and regulate their enterprise for the realisation of some norm. Again sometimes the term science is used in a narrow sense to denote only experimental studies. In this sense some social sciences will be excluded from the scope of science. But the term science is usually used in such a way that social sciences are a part of scientific study. We shall see that what we generally call

science has a distinct method as well as subject matter. Particularly the scientific method plays an important role in determining the scope of science from non-science.

Similarly the term scientific is generally used to mean reasonable explanation. Facts of experience are scientifically explained by following a definite procedure which is chatracterised as scientific procedure. That means scientific explanation follows a general pattern of reasoning. In this pattern of reasoning conclusions are derived on the basis of empirical evidence. Any inquiry whether in professional science or in practical situation that adopts the general pattern of reasoning is characterised as scientific. In the course of illustration this will be discussed in this chapter.

Leaving aside the broad or the narrow sense of science let us see how it is generally used. Science is described as a systematic body of classified empirical knowledge obtained by the inductive procedure. This description includes natural science as well as social science in the fold of scientific discourse. For in each case we derive systematic knowledge about the facts or phenomena that we come across. Facts, events and processes may relate to nature or to human society. While physics, chemistry, astronomy, etc. come under the spere of natural science, sociology, economics, politics etc. come under the spere of social science. The former group of sciences studies natural phenomena by systematically classifying them, the latter group studies in a like manner the social events. For our convenience we categorise them and bring them under different branches. More progress means more specialization. Thus while natural sciences explain natural phenomena the social sciences explain social events. Both the areas deal with facts of experience. Any observable phenomenon can be brought under some specialized branch and be explained under the methodological procedure of science.

Thus when we describe scientific knowledge as something empirical, it means its realm consists the facts of experience. Facts of experience mean what is observable. We observe the phenomena by help of our sense organs. By our sense organs we know the external world. But

sometimes our sense organs are not capable to preceive some phenomena because of their complexity, distance or peculiar nature. So some apparatuses or even very sophisticated instruments are used to make our study accurate. For example, we use a telescope to see very distant things even the heavenly bodies, an X-Ray instrument to know the inner part of human body, a stethoscope to listen the heart and its sound etc. Thus what is observed either directly or indirectly, either by crude sense organs or by some sophisticated instrument, either from nature or under controlled conditions are termed as empirical facts.

Hence scientific knowledge is basically and fundamentally about the world of empirical facts. Scientific inquiry does not admit any supernatural or mystical events. According to the assumption of science nothing is supernatural, theological or mystical. Something is supernatural if in principle it violates the natural order. There are mysteries in nature but no miracle or supernatural event. A miracle is supposed to be an event that defies a well-established law of nature. Thus the realm of science is quite incompatible with the idea of supernaturalism or miracles.

Further scientific knowledge is progressive. Any theory of science is subject to change and modification in face of new evidence or fact. No scientific theory is infallible or sacrosanct. Since nature is vast and unlimited our knowledge of nature cannot be final or ultimate. More progress in civilization means more exploration in the secrets of nature. According to Bacon the book of nature is lying open before us to be explored and studied. What was a mystery in the past comes to the comprehension of a school-boy now and what appears a mystery at present will be explained in the days to come. The horizon of scientific knowledge is ever expanding with new discoveries and explorations.

The most important characteristic feature of the scientific inquiry is its methodology. The scientific method provides the most viable and regenerative process of acquiring dependable knowledge. The scientific method is always faithful to objectivity or realm of facts. That means the scientific method consists of observation of facts, formation of

hypothesis and confirmation or verification of the hypothesis. Facts, events, processes, happenings etc. need explanation. To seek an explanation means to give reasons why something is as it is. There are innumerable phenomena occurring around us and an inquisitive mind seeks to explain them. Explanation demands observation. After careful observation we form a hypothesis to account for a possible explanation. Suppose a disease is to be explained. Some hypothesis can be formed after observing the relevant facts. The hypothesis needs to be verified by further observation. If the facts corroborate the hypothesis in question, then it will be accepted. Lest the hypothesis will be rejected and a fresh one may be imagined. A scientific hypothesis must be tested or in principle must be testable either to confirm it or to reject it. This process continues till the proper explanation is found out. Once a hypothesis is confirmed it can act as a law or theory to explain same events under similar conditions. This procedure constitutes the significant feature of scientific method.

Thus the realm of scientific knowledge consists in the procedure or method that is adopted to have systematic knowledge. This procedure keeps some studies outside the realm of scientific knowledge. Subjects like astrology, palmistry, numerology etc. give the impression that they have a scientific basis. But their areas do not fulfill the basic requirements of scientific study. An astrological prediction is not like a scientific genralisation. The possible laws of astrology or palmistry are not based on the principle of causality. Nor are they linked with any coherent system of knowledge. When exceptions are noticed in astrological predictions, the laws are not rejected. Rather astrologers or soothsayers take their generalisations or laws as infallible. This is quite contrary to the very spirit of science. Thus science deals with phenomena which are observable, and follows a distinct method to explain them.

Thus scientific knowledge is systematic and methodical. Science systematizes the facts and classifies them by following some order. Every branch of science centres round some very key concepts. Whether it is a branch of social science or natural science the facts are collected, observed, systematized by help of some important ideas. The observed facts are welded together

and explained by help of some definite set of ideas. Science aims at establishing an order in the process of systematization. Reaching an order is the very purpose of science. Let us see the concept of order in science.

7.2 ORDER IN SCIENCE

Though the purpose of science is to explain the facts, it does not restrict itself to explain facts at random. Rather it systematizes the facts and builds up theories to provide scientific explanation to them. In the process it formulates theories on the basis of observation. Facts are arranged and systematized according to a definite order by science. Unless facts are systematized following some ordered principle, there cannot be a scientific illustration of the facts. The classification and systematization of facts or phenomena are not done following any a priori rules. Rather on the basis of observation of facts a hypothesis is formed to provide an explanation of facts. When facts exhibit important points of resemblance, some law is formulated in form of a hypothesis to explain them. A law or generalistion is supposed to explain the instances or a group of events. Different hypotheses, theories, and laws are formulated and classed following some order or pattern in the process of their systematization. The empirical laws are systematized both horizontally and vertically in order of their generality. In every branch of science different generalisations are made and the generalisaions and laws are brought under horizontal order. Ultimately any branch of science exhibits some basic laws which are the product of horizontal subsumption. Again the different branches of natural sciences make a coherent system and follow some vertical order. The empirical laws are subsumed under some higher laws which again give rise to some still higher laws or theories and ultimately some non-instantial theory or hypothesis. Each higher theory provides justification for some laws that follow from it. In the descending order ultimately we have the generalisations as a result of the observation of facts or instances.

Thus the very object of science is to establish an order among the facts. For a fact or even a generalisation does not constitute a system of science in isolation. Further in the early phase of scientific inquiry scientific explanation was identified with the causal explanation. That

means it is considered that science seeks exclusively a causal order. But modern thinkers bring out different orders and do not take all orders as identical with the causal order. Different branches of science have passed through different stages of development till now. The order used in science reveals its stages of development. These orders indicate the successive progress of development of the sciences. These orders also indicate the type of explanation that is sought. There are various kinds of explanations according to our plan or purpose. Generally four orders are discussed to mark the stages of development of science. These are :

1. Classificatory order
2. Causal order
3. Mathematical order
4. Theoretical order

7.2.1 CLASSIFICATORY ORDER:

The most familiar order is the classificatory order. Here things are recognised as belonging to one category and are assigned names. We assign names such as 'dog', 'cat', 'milk', 'tree' etc. to individual things and make each of them a distinct class. A layman also classifies things, animals or events into classes. In the most primitive stage of man's history things, events or animals have been classified on the ground of natural similarity. On the basis of natural resemblance the dogs make a class as the members resemble one another on important points and differ from other classes. Dogs are different from cats as cats make a class on the basis of inherent resemblances. This classification is done mostly from a practical point of view.

But in science the classificatory order is introduced on the basis of structural similarity. On the ground of certain characteristic resemblances classification is made. Cats, dogs, cows, whales are classified as mammals; iron, copper, lead, mercury are classed as metals; and iron, oxygen, gold…. are classed as elements on some deep seated points of similarity. A structural

similarity is connected with some important properties. Thus scientific classification helps to know the important or structural points of resemblances among the members and the invariable properties associated with them. Classification of man on the basis of caste, religion, nationality etc. is an artificial or superficial classification whereas classification on the basis of sex, blood group, dominating racial character etc. is a structural classification. Scientific classification on the basis of structural resemblance also reveals common invariable properties. Thus classificatory order is used in science to classify things on the basis of certain deep-seated functional similarities.

Though the process of classifying and cataloguing is the lowest level of order in science, still it widens our knowledge and deepens our understanding. For our knowledge of classification helps to know or infer the properties of the said class. So the process of classifying our experience will never be complete.

Some less developed sciences like genetics, psychiatry, life science etc. mostly follow this classificatory order.

7.2.2 CAUSAL ORDER:

Causal order is frequently used in some branches of science. Particularly at the earlier stage of scientific development causal explanation was considered to be the sole object of scientific inquiry to explain a phenomenon or a class of facts. This causal explanation involves a temporal span between two phenomena related as cause and effect. Generally from the popular or common-sense notion of cause emerged a scientific view of cause. Some philosophers like Mill identified the causal order as the sole purpose of scientific induction. For inductive generalisations based on causal connection are most dependable. But with the progress of science the causal explanation is not given supreme importance as it was done at the earlier stage of scientific progress. It is accepted as one kind of explanations. But there are other explanations as well. Of course in some areas like medical science, sociology, history etc. causal explanation is very common. In medical science attempts are frequently made to find out the cause of diseases in order to prevent them. In sociological studies causal explanation is sought to know the background of some social

events. In some cases causal explanation is not that easy because of the intricacy or complexity of the phenomenon sought to be explained. A genius having great reflective insight can discover the cause of a natural phenomenon after a lot of investigation or by trial and error. Theoretically the causal relation is temporal in nature for the cause always precedes the effect and the effect comes after the cause. Causal relation is also an invariable association between two phenomena. Causal relation is also an asymmetrical one.

Causal order introduces systematic presentation of phenomena and is considered to have higher explanatory power than the classificatory order.

7.2.3 MATHEMATICAL ORDER:

In some developed sciences generalisations are expressed in numerical equations. This is called mathematical order where uniformties of nature are quantitatively expressed. When inductive generalisations are formulated in mathematical relations we have mathematical order in science. Laws in physics, astrophysics, chemistry etc. are expressed in this way. Laws relating to sound, electricity, heat etc. are expressible in terms of mathematical formula. These generalisations refer not to particular cases but generally hold in all cases. They have wider scope and even a type of scientific certitude. Where this order is present, scientific explanation in that area is more accurate and systematic.

In very developed areas of science, generalisations are abstract and they are stated in mathematical terms. Generalisations of this type never assert a causal order.

7.2.4 THEORETICAL ORDER:

This order is expressed in most developed areas of science. Some very comprehensive theories are constructed which will provide the ground to accept different laws or generalisations. While different generalisations obtained at lower stages of scientific inquiry are objectively confirmable either directly or indirectly by observation of facts, a comprehensive theory provides objective justification to the genralisations but unlike the former is not so observable. In the process of systematizing the generalisaions or laws of science a comprehensive theory is

constructed. Such a theory is comprehended at an abstract level by a genius. The non-instantial hypothesis, a term with which we are acquainted with, in the previous chapters, comes under this category. This theory provides a systematic order to many laws of science. That means various uniformities or laws are systematized and are made a coherent system by help of this theory. The theory has wider applicability and it possesses a higher degree of generality. It has great explanatory power as it systematizes and unifies scientific knowledge to a coherent system. Newton's law of gravitation was sometimes understood to be a very comprehensive law. Later on Einstlin's theory of relativity introduced higher order as it showed greater explanatory power in systematizing many laws along with the law of gravitation.

A comprehensive theory not only systematizes our knowledge of science, it introduces a vertical order as it forms the basis for other laws or generalisations. It justifies that the uniformities, generalisations or laws which are confirmable either through observation or experiment are not isolated from one another. Rather they are the consequences of the inclusive order expressed by the theory. The theory is very comprehensive and more abstract than the laws established in science.

Thus scientific induction, generalisaions, discoveries and construction of theories come under these four orders. Even these orders are illustrated to represent the four stages of advancement in the different branches of science.

7.3 SYSTEM IN SCIENCE:

Order, we have discussed, refers to the manner in which facts are systematized and unified. It helps to understand the explanation of facts in systematic ways. Order comes when theories are constructed or laws are discovered. Theories and laws are generalisaions. But isolated generalisaions do not constitute a system of knowledge. The object of science is to present a systematic interconnection of the laws. The laws are interconnected to constitute a system. That means a system is the result of the orderly arrangement of the laws that explain the facts.

A system, as is ordinarily understood, has constituents. The constituents mutually support

each other. In a scientific system when some laws are unified under a coherent principle of higher generality that gives insight to understand the laws as well as the system in a more satisfactory manner. The constituents of a system are mutually compatible with one another and are not a loose bundle. But though the laws belonging to a system are compatible and coherent, they may not be of the same level. Even within a system some of the laws may be having higher generality than the other. In that case the theoretical order among the laws will be vertical. For in such a system the lower level laws will be deduced from the higher level ones. In the series of the system the laws at the lowermost level are ascertained by observable evidence whether direct or indirect. If the laws or generalisaions at the lowermost level are supported by the observable evidences then that provides a basis for the indirect justification of the higher level laws and the system itself.

Not only the physical sciences establish systems, the formal studies also have coherent systems. Rather the system in formal sciences like mathematics and logic is more neat and definite as it is purely deductive in nature. For example, in mathematics from a few chosen axioms all propositions in the system are deductively derived by help of some definitions and rules. There can be different deductive models having each model its own axioms and definitions. Each model is coherent and consistent, for every proposition or theorem is a necessary corollary within the system. That means the system enjoys consistency and independence for every proposition within the system is logically derivable. Because of this characteristic feature a deductive system is described as pure as the propositions of the system are independent of empirical fact or our experience. But the system that is established in empirical sciences is somewhat different. Within a system of science the theories which are constructed and the laws which are discovered might be making a coherent system, but any generalisaion or proposition in the system is not a logical corollary but has its ultimate justification in its objective verification of facts. That means in a system of science the lowermost generalisaions or laws are ascertained by their agreement with facts. The veracity of a law in science is founded not on its derivability, but on being faithful to the facts. Hence even though physical sciences build up systems in a well-formulated manner just like the systems of formal sciences, there is remarkable difference between their systems. The

systems in physical sciences are ultimately fact-based unlike the systems of formal disciplines. Thus a system is coherent within itself, every law within it is consistent with other laws and with the system as a whole; a law even may be deduced from its higher law and ultimately must be in agreement with the empirical facts.

In different branches of science there may be different system of laws. Any branch of science has its own laws. A set of laws in a science establishes a system and there may be different systems. As science progresses there is more and more systematic presentation of the facts and laws. From a theory other laws are deduced and the laws ultimately remain faithful to the facts of observation. This is most conspicuous in developed branches of science like physics. Galileo's law of acceleration or Kepler's law of planetary motion had systematized facts and accorded scientific explanation to them. But Newton's law of gravitation provided a more comprehensive system and systematized these laws. That is Newton's system possessed more explanatory power as its range was wider than the systems prevailing before him. Again Einstein's theory of relativity still introduced a more comprehensive system as it encompassed a still larger sphere. It explains Newton's law of gravitation and much more facts which Newton's system fails to incorporate within its fold. Thus Einstein's theory of relativity stands at the apex of the systems in physics for it unifies most of the laws so far discovered. But it is not correct to say that the process of systematization has reached its final stage. Though the system has made spectacular progress among the empirical sciences as it is getting increasingly widened by explaining new facts even in unanticipated spheres, still the possibility of a more higher non-instantial theory cannot be ruled out. For systematization of theories, laws and facts is still open-ended and cannot be said to have been completed. That is because science gives us progressive knowledge of facts and man's quest for it will never be final for all times to come.

Thus system building is the very object of scientific inquiry. In its theoretical framework it brings facts under uniformities, uniformities under laws, laws under higher laws and finally establishes some principles or theories. Hence from the theories of higher order to the facts of observation there are many intermediary stages. The laws at the lowest level are supported by facts of

observation.

This process of science makes it a deductive system as the laws are deduced from laws of higher generality. But this deductive system in science is impure because unlike mathematics or logic the system in science goes beyond and seeks its justification in the world of facts.

7.4 SCIENTIFIC METHOD:

Scientific method is the most dependable technique that is used to obtain systematic knowledge. By using this assured technique we try to know the facts and their true nature. It is adopted by the empirical sciences to build up their systems. Though the subject matter of sciences differs from one another their procedure remains almost the same for all empirical sciences aim at giving explanation of facts and phenomena with which they deal with. They want to make their observation or experiment accurate, generalisaions exceptionless, explanations satisfactory and knowledge systematic and dependable. Hence the method they want to employ will be such that it would discover the facts in their true nature. Knowledge of facts is the basic objective of sciences. To have knowledge of facts we reflect upon what we observe. We systematize and classify them so that we can have satisfactory explanation. But simply collecting the facts will be idle unless there is some felt-need to explain some facts. So there must be an intellectual inquisitiveness behind an explanation. A proper explanation of the facts can fulfil the goal and terminate the inquiry.

To make a new discovery on the basis of observation of facts requires great insight. An extraordinary genius can make a scientific innovation. The scientific method is the very basis of carrying out the search. The empirical sciences, both natural sciences or social sciences, adopt a common procedure to explain the facts. Systematization of facts, their classification, inductive generalisaion, discovery of exceptionless regularities or laws, construction of theories etc. are a part of scientific illustration. That is done by the use of the scientific method. Thus the scientific method is the most assured technique that has been devised for explanation of the facts.

The scientific method is usually the same as the inductive procedure. We have already discussed the different stages of inductive procedure in the chapter "Nature, Procedure and Problem of Induction". The scientific method usually consists of the steps like observation of facts, formation of hypothesis and verification of the hypothesis by deduction and further observation. To the scientific mind some facts pose problems as the scientist wants to know why they occur. He seeks to know the law behind the observed phenomena. To find out an explanation he formulates a hypothesis. Formulating a legitimate hypothesis is not that easy a matter. It requires deep insight and creative imagination. The confirmation of the hypothesis is an essential need in scientific inquiry. The consistency of the hypothesis with the established laws is considered important. Facts constitute the sole basis for the confirmation of the hypothesis. In case of non-instantial hypothesis a deductive procedure is maintained for its verification. If contrary evidence is found at any stage of verification then the hypothesis is either modified or discarded. Where direct verification of the hypothesis is not possible, it is in fact not possible in case of many theories, the hypothesis is indirectly verified by the deductive method. Since deduction has a significant role in the confirmation of the hypothesis some logicians call this process hypothetico-deductive method in stead of inductive procedure. But basically the inductive procedure and the scientific method are not different from each other. The inductive procedure is used in a wider sense to include unification and systematization of the laws of science and not simply for isolated generalisations. Systematization of the laws by using some order is the object of science. The scientific method includes the process of unification of the generalisaions.

Logic as a process of reasoning is not to examine the scientific investigation, the laws or theories. But it is primarily concerned with the method that is used in science. For logic examines the methods that are employed to build up systems of knowledge. The method that is generally used to build up systematic knowledge in every branch of science comes within the scope of logic. For logic examines the reasonableness of a method and its possible limitations.

Unless the method that is used in a system of knowledge is cogent, the product of the inquiry will not be true. Logic justifies the scientific method or the procedure of induction as the most assured technique to be employed in empirical sciences.

7.5 SCIENTIFIC EXPLANATION:

If a fact appears puzzling and with the existing knowledge it is not possible to explain it, then an explanation is sought to make it plain and clear. Hence a true explanation of the facts, events etc. extends our knowledge. Man's inquisitiveness along with search for a scientific explanation has expanded man's intellectual horizon. Though man's inquisitive mind seeks explanation when he comes across a puzzling phenomenon all explanations are not scientific or reasonable. A scientific explanation is different from a popular explanation. The former is very much dependable as it is in accordance with the scientific procedure. But before going to discuss the nature of scientific explanation, some popular or unsatisfactory explanations should be pointed out.

Human thinking has passed through different ideas at different times. In ancient days people were satisfied with supernatural or mystical explanations. They tried to understand natural phenomena as the acts of some supernatural power. Natural events like rain, eclipses, calamities, death, disease etc. were explained by fostering supernatural causes. The belief that a natural calamity is due to the wrath of a deity or that the solar eclipse is the result of a dragon's swallowing the sun is not a rational one. Here there is no scientific explanation. For a scientific explanation does not accept any supernatural cause or mystical occurrence. Scientific explanation accepts natural causes or laws whether they are known or not. There are many facts which have not been explained in spite of great efforts. So there are mysteries. What has been a mystery may be explained with new innovations and discoveries. But the possibility of there being some supernatural cause of a natural phenomenon is quite incompatible with the very spirit of scientific explanation.

Similarly some explanations are unsatisfactory. They do not fulfil the basic requirements of scientific illustration. Any attempt to explain some phenomenon by bringing synonymous

expression of the term referring the phenomenon does not serve any useful purpose. If one says that a mother takes care of her baby because she possesses a maternal instinct, then his explanation is unsatisfactory. Because it virtually gives no explanation except that it is not learned. Similarly if one says robin is a migratory bird because it has migratory instinct, his explanation is unsatisfactory. For it does not say what is a migratory instinct or why robins migrate but not cuckoos or crows.

Teleological or purposive explanations are not considered as scientific explanations. Purposive explanations are accepted in case of actions of human beings. Behind an action of a person there might be some intention. A student labours hard to secure a good rank in the examination. So the student has a purpose. But sometimes purpose is attributed in case of natural facts or events. Sun rise, sun set, rotation of seasons, rain, cyclone, blossoming of flower etc. are natural events which can be explained by natural causes. To attribute some purpose to some agent or power in case of natural phenomena is not a scientific explanation. A purpose presupposes a purposer and no purposer is there in natural events. Descriptive laws of nature are not governed by any purpose.

In practical life sometimes explanations are advanced on the basis of similarity between two phenomena or situations. When two things are found similar on some points some explanation is given bringing their resemblance. But an analogical explanation does not serve a scientific purpose unless it is linked with some deep-seated points or law. Suppose if it is said that death is nothing but like discarding a torn cloth, then there is no explanation of death. If it is said that when a cloth is torn, it is discarded, so also when the body is old or diseased it is discarded. This analogy is a metaphorical description, but not a scientific explanation.

Before a phenomenon is scientifically explained it is necessary to categorise it by the process of classification. Classification means assimilation and discrimination as well. If there is a perplexing phenomenon which is beyond the scope of our known laws, then it is necessary to classify it. To classify means to know its class pattern or its group-nature. When it is classified, it is also discriminated from the group of laws to which it does not belong. Then it is assimilated.

After assimilating it properly, attempt can be made to explain it by help of some law or hypothesis.

Scientific explanation is systematic, methodical and mostly unified. Here facts are explained with the help of laws or regularities of nature. While popular explanation is concerned with particular facts, scientific explanation brings facts under some established laws. The explanation of facts, events, occurrences, processes etc. consists of reference to some law or uniformity of nature. It begins its inquiry with the question "why something is the case?" why iron rusts, why lightning precedes thunder, why night is longer than day in winter etc. are events. Through explanation of events scientific explanation establishes general laws. That means scientific explanation is interested to discover the causes behind these events. When the cause of a phenomenon is known, it acts like a law. Science unifies the unrelated facts and brings them under some laws. Facts are explained by laws, laws are also explained by higher laws or theories. We have already explained it in the context of system in science. That holds it here also.

Thus any phenomenon is explained if it is taken to be the result of a law or deducible from the law. In science laws make a coherent system and no law is an isolated generalisition. When a phenomenon is deduced from a law or the law acts as its explanation, then it is explained. Explanation thus consists of some propositions including a law from which the phenomenon or thing to be explained can logically be inferred. Thus explanation acts as the premise and the fact sought to be explained as the conclusion. Since the law is probable upon which the explanation of the phenomenon depends the explanation will have probability only.

Every scientific explanation is in accordance with the scientific procedure that consists of some well defined steps. It primarily includes observation of facts, formation of hypothesis and its verification. Basically an explanation is like a hypothesis, so the conditions that are required for a legitimate hypothesis also hold good in case of a scientific explanation. The evaluation of a scientific explanation depends upon some criteria. Sometimes there is more than one explanation for the same fact. Even there may be different theories to account for a group of

facts. Thus in such cases where incompatible or alternative explanations are present, it is necessary that explanations must be evaluated. Evaluation of explanations, either as good or bad, or as better or worse, requires certain criteriological consideration. Some criteria such as relevance, testability, consistency with previously established hypotheses ,explanatory power and simplicity are fixed for that. An explanation is not intended for its own sake but to explain some fact or other. So it should be relevant to fact it intends to explain. That means the fact in question should be deduced from the hypothesis that is given as an explanation. Again the explanation must be in principle testable. A hypothesis supposed to provide an explanation to a fact must be connected directly or indirectly with facts of experience. Any explanation must not violate a well-established hypothesis. Of course science gives progressive knowledge, so new theories sometimes shatter the old cherished ones. Ordinarily a hypothesis need not contradict an established theory, but in face of incompatible theories, the theory that fits in better with the body of scientific laws is to be preferred. This implies the next point in the criteria i.e. an explanation must have predictive power. The explanation advanced in favour of a fact not only should explain that particular fact but be like a law to explain all facts of that type. That means the supposed explanation should have greater explanatory power. The greater the explanatory power, the more satisfactory is the explanation. An explanation which is more simple and not very complex and complicated draws attention. It is of course difficult to define simplicity. But in case of two competing theories of explanation the simpler one is accepted.

Different logicians classify scientific explanation differently. We shall discuss Nagel's classification as it presents a comprehensive form of explanation. Nagel classifies scientific explanation into four types. They are:

i) Deductive model explanation

ii) Probabilistic explanation

iii) Functional explanation

iv) Genetic explanation .

Let us elaborate them.

7.5 (i) Deductive model explanation:- We have discussed that facts are explained by laws, laws by higher laws or theories. There is a deductive order as laws are subsumed under higher laws. So within a system a law of lesser generality is deduced from a law of higher order as the latter explains the former. That means the law to be explained is deducible from the law that explains it. Newton's law of gravitation is deducible from the theory of relativity and the law of gravitation explains the movement of the planets. Thus within a system of laws there is a logical order in accordance with the principle of generality. This kind of explanation is possible only in case of most advanced sciences like physics or chemistry. This type of explanation is considered as most satisfactory.

7.5 (ii) Probabilistic explanation:- When an explanation is given on the basis of statistical data, it is called probabilistic explanation. Here the supposed fact is expected on the basis of statistical findings. So there is no strict law from which the fact can be inferred. In less advanced disciplines like biology, sociology etc. this type of explanation is usually given.

Suppose from case histories it is found that 80% of drug addicts suffers from mental abnormality. If a particular person is a drug addict and has abnormality our explanation is probabilistic for it is not strictly deducible from the law. Because this generalisation does not cover all cases, so someone being a drug addict and having no mental abnormality cannot be ruled out.

7.5 (iii) Functional or teleological explanation:- In practical life very often this type of explanation is given, so it is also called the primitive explanation. Here a fact is explained by tracing its role or function in the system. For example, if one asks, "how is food digested?" Glands in stomach secret juices that help in digesting food. " Why are there living beings on the earth?" Because the ozone sphere is there above the earth to absorb the harmful rays of the sun so that living beings can exist on earth. These are functional or teleological explanations. Here some purpose is attributed for the occurrence of some events. Purpose is used in the sense of intention as if such things are done intentionally. But no such intention can be known in case of natural events. So such explanations are called functional explanations.

7.5 (iv) Genetic explanation:- When some process develops in a way to finally come to a result it is called genetic explanation. Here through a course of development some result comes. That means something passes through different phases to an end. Achieving independence is explained as the final outcome of a series of successive events. From musquito bite starts the incubation and finally results in malarial fever. Here an event is explained as the consequence of a series of developments through some intermediary links.

Though scientific explanations are most trustworthy, there are some ideas which cannot be explained. That does not mean there can be other explanations. But their very nature makes them unexplainable. No scientific explanation is possible in case of ultimate laws. Facts,events, processes etc. are explained by laws and the laws by higher laws or theories. But when we reach an ultimate law in a system that cannot be explained. The elementary structures or processes do not admit any explanation. They are the "brute facts" of nature. Our elementary sensations and the peculiarities of individual objects can not be explained. Where things or some property cannot be linked with anything else, it cannot be brought under scientific explanation.

Scientific explanation thus refers to a process which stands for rational illustration of things. It proceeds from facts of experience to most reasonable explanation of those facts. It is not only the professional scientists who use it, but anyone interested in a proper explanation can follow its procedures. It has universal applicability. Because of its universal application the scientific method which is at the background of scientific explanation is termed as scientific temper. It helps to promote the spirit of inquiry and rational attitude.

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SUMMARY

Science is described as a systematic body of classified knowledge obtained by the inductive procedure. Its characteristics are –

i) Scientific knowledge is empirical

ii) Its theories are not infallible

iii) Scientific knowledge is obtained through a dependable procedure

iv) It always remains faithful to facts.

ORDER IN SCIENCE:

Science does not explain facts at random. It systematizes the facts and formulates theories,

Different branches of science make coherent systems and follow some order. The order that is used in science reveals its stage of development.

Four orders have been discussed in philosophy of science. They are

i) Classificatory order

ii) Causal order

iii) Mathematical order

iv) Theoretical order

SYSTEM IN SCIENCE

A system is the result of the orderly arrangement of the laws. The constituents of a system are mutually compatible. Within a system some laws might have higher generality than others.

Unlike formal science, in physical science a generalisaion or theory is never a logical corollary. The process of system building in science is open-ended and is not final.

SCIENTIFIC METHOD:

All branches of science deal with different subject matter. But they aim at systematization of facts, classification of data, generalisation, discovery of exceptionless regularities or laws, construction of theories etc. The scientific method is usually the same in all branches of physical science.

SCIENTIFIC EXPLANATION:

Scientific explanation is systematic, methodical, objective and unified. It is different from teleological or purposive explanation.

A scientific explanation is in accordance with the scientific procedure which includes some well defined steps.

Nagel brings out four kinds of explanations. They are-

i) Deductive-model explanation

ii) Probabilistic explanation

iii) Functional explanation

iv) Genetic explanation

Scientific explanation has some limitations. Where scientific explanation is not possible, there is no other explanation to be followed.

MODEL QUESTION

GROUP - A

Objective Questions :

1. Answer the following:-

a. What is the board meaning of science ?

b. Which branches of science are goal-oriented ?

c. Does science admit supernatural explanation ?

d. How does science classify facts ?

e. What is the basic objective of science ?

f. How does Nagel classify scientific explanation ?

g. What is genetic explanation according to Nagel ?

h. Is scientific explanation possible in case of ultimate laws ?

2. Fill In the blanks:-

a. Mathematics is considered as a _____ science.

b. Eithics is a _____ science.

c. The scope of science is determined by the scientific _____.

d. When facts or things are classified on the basis of natural similarity it is called _____ order.

e. A set of laws in a branch of science establishes a _____.

f. Science gives progressive knowledge of _____.

g. Science unifies facts and brings them under _____.

h. In science laws make a coherent _____.

GROUP - B

Short-type Questions :

1. Answer the following :-

a. What is scientific explanation ?

b. How do we know the external world ?

c. What is an empirical fact ?

d. What is scientific generalisation ?

e. What is classificatory order ?

f. Explain the significance of a causal order.

g. Give an illustration of the mathematical order.

h. What is theoretical order?

i. What is a system in science ?

j. What does vertical order mean in science ?

k. What is meant by deductive model in mathematics?

l. Explain what is meant by teleological explanation.

m. What are the limits of scientific explanation ?

GROUP - C

Long-type Questions :

1. What is meant by order in science ? Explain.

2. State and explain what is meant by system in science.

3. What is the significance of the scientific method ? Is it the same as the inductive procedure?

4. State and illustrate what is meant by scientific explanation.

5. What sort of explanations are unsatisfactory according to science? Discuss.

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CHAPTER-8
SIMULATING INDUCTION (OR INDUCTION IMPROPERLY - SO - CALLED) AND INDUCTIVE FALLACIES

8.0 PROCESS SIMULATING INDUCTION:

There are some inferences which appear like induction but are not really so. Such inferences are called processes simulating induction. They only pretend or simulate to present some induction. They are not induction because they lack the essential features of induction. In some textbooks they are described as induction improperly so called. Modern logicians do not consider them as induction, as these processes do not possess the defining characteristics of induction. Three kinds of simulating processes of induction have been generally discussed in the textbooks. They are-

i. Perfect induction.

ii. Parity of reasoning.

iii. Colligation of facts.

Now let us discuss their nature and characteristics.

8.1 PERFECT INDUCTION:

Perfect induction is also called induction by complete enumeration. It establishers the material truth of an apparently general proposition on examination of each and every instance covered by it. In induction by complete enumeration, as the very name suggests, we separately verify every instance coming within the scope of a universal proposition for establishing a conclusion. Here it is observed that a certain characteristic is found in respect of every individual member of

a class. On the basis of this observation we make a statement in the form of a universal proposition. Let us take some example to illustrate it.

a. Suppose we find that every continent in the world has seas. Asia has seas, Europose has seas, and so too every continent. Therefore we conclude that every continent has seas.

b. Suppose every student of a particular class is found to be an Odia.

All the students of this class are Odias.

Symbolic example:-

C_1, C_2, C_3 ……. Cn of the class C are P.

C_1, C_2, C_3 ……. Cn are all the members of C

$\therefore$ All C's are P's.

Here though the conclusion is a universal proposition, it is only apparently so for it has limited or countable number of individuals. Since the members of the class are limited it is possible to examine each member of the class separately to establish a conclusion. Induction by complete enumeration will not be possible where a class has unlimited members or where it is not possible to examine every individual of the class. In other words induction by complete enumeration is possible where the members of a class are limited and can come within the scope of individual examination.

In induction by complete enumeration there is observation of facts so the conclusion is a real proposition. Here the premises are obtained from experience and there is novelty in the conclusion. But it lacks any inductive leap. Since there is no inductive leap there is no generalisation here. It means there is no passage from the known to the unknown or from the observed to the unobserved instances. Since there is no generalisation here, the law of uniformity of nature or the law of causation does not apply to it. As it lacks all these essential characteristics of induction it is not induction though it appears to be so. The conclusion is only a summation of singular statements and does not make any advance by going beyond the premises. So there is no genuine inference in this case. Therefore it is called a process simulating induction.

8.2 PARITY OF REASONING:

Parity of reasoning is another process of simulating induction. This process of inference is applied in formal science like mathematics. Particularly it is applied in geometry. Though parity of reasoning gives the appearance of making a generalisation, in reality it is not at all a form of induction. On the contrary it is substantially a deductive form of reasoning and has nothing to do with induction. Hence it is considered as simulating induction.

Induction by parity of reasoning is the generalisation of a truth on the basis that the same reasoning which has proved a particular case will apply in every other similar case. Suppose we prove in geometry that the two adjacent angles make two right angles; or that the three interior angles of a triangle make two right angles. The proof that is given in one case is applicable in every other similar case. Whatever proof justifies the case that two adjacent angles are 180^0, will be applicable in every case of adjacent angles. Or the proof that justifies that the interior angles of a triangle are 180^0, will hold good in case of every triangle. In algebra we also apply the same procedure of reasoning. Suppose we prove that $a^2 - b^2 = (a + b)(a - b)$. On this basis we conclude that the difference of the square of any two numbers is equal to the product of their sum and difference. The symbolic expression of this from of reasoning is:

S_1 is necessarily P.

$\therefore$ All S's are necessarily P.

It is to be noted that conclusion in parity of reasoning is a mathematical proposition. And a mathematical proposition is necessarily true as it is drawn from some axioms, definitions and theorems. The conclusion appears as if there is a generalisation but it is not on the basis of observation of facts. The conclusion is a deductive one and the basis for this deduction is similarity in reasoning. The reasoning or proof that justifies a mathematical proposition will also apply in every other similar case. In fact any single proof makes a theorem. In the examples, the concept of an adjacent triangle stands for any adjacent angle or a angle represents every triangle.

Further in parity of reasoning there is no observation of facts. By the help of some axioms, definitions and corollaries different theorems are proved. A triangle, for instance, is not a particular instance of triangles rather stands for the whole class of triangles. It is an abstract idea. So here there is no observation of facts of experience.

As there is no observation of facts, there is no inductive leap in parity of reasoning. When we draw a diagram of triangle and prove that its interior angles make two right angles it is not that we are passing from known case to unknown cases. On the other hand what is proved in case of a particular diagram is a statement about all similar diagrams. Further the idea of uniformity of nature or law of causation has nothing to do in this form of reasoning.

Hence parity of reasoning is not at all inductive, rather it is deductive in nature. As it is deductive its conclusion is logically certain and its opposite is self-contradictory. While the conclusion of an induction is probable, the conclusion in parity of reasoning is certain.

Thus parity of reasoning is not based on observation of facts. It has no inductive leap nor is its conclusion probable. It is not an inductive form of reasoning but it only simulates induction.

8.3 COLLIGATION OF FACTS:

Literally colligation means to bind together. Colligation of facts means the binding together or the mental union of a set of observed facts by means of a suitable notion. It is the application of a suitable idea or notion to a number of actually observed phenomena. According to Mill's definition colligation of facts is the mental operation, which enables us to bring a number of actually observed phenomena under a description, or which enables us to sum up a number of details in a single proposition.

A passer-by accidentally comes to a building without knowing whether it is an academic institution, an administrative building or a private house. He enters into the building and finds class rooms, laboratories, library, Principal's chamber, teachers common room etc. He colligates these facts and brings them under the idea college or educational institute. For the word college is suitably applicable to his observed phenomena. This can be presented by the following symbolic

example-

S has the properties P_1, P_2, P_3 and P_4

Whatever has the properties P_1, P_2, P_3 and P_4 is P.

$\therefore$ S is P

So far the characteristices of colligation of facts are concerned we find that it is the process of forming a concept. It establishes a notion but not a proposition. It can also be taken as an illustration of classification. For just as in classification there is mental grouping of facts so also in colligation of facts there is mental grouping of facts under some suitable idea. Of course the observed phenomena may be expressed by a singular proposition, the building runs an educational institution in the above example. But in spite of that here the mental grouping is concerned only with one notion i.e. educational institution. Colligation of facts is based on observation of facts. Without observing facts, these cannot be brought under any idea. There is no question of inductive leap here. We do not pass from certain observed facts to unobserved facts. Further from the symbolic example stated above, it appears that colligation of facts is more deductive than inductive in nature. The logical form of reasoning in colligation of facts is-

Whatever has the properties P_1, P_2, P_3 and P_4 is P

S has the properties P_1, P_2, P_3 and P_4

$\therefore$ S is P

The above example shows that it is a kind of deduction. But the argument is not purely formalistic in nature because the minor premise is based on observation of facts. Unless something is empirically observed it cannot be classified under a suitable notion. So colligation of facts may be expressed in form of a deductive argument, but it cannot do away with observation unlike that of deduction where there is no appeal to facts.

The question of the law of causation or the law of uniformity of nature does not arise in case of colligation of facts. As different facts are observed and brought under a notion this process has nothing to do with the law of causation or the law of uniformity of nature. It is a

mental union of facts. But it does not explain facts unlike that of scientific induction. It simply brings a set of observed phenomena under some notion. It is like a process of classification but not an explanation of facts.

There is a good deal of controversy over the issue whether colligation of facts be considered as induction or not. William Whewell holds that colligation is the same as induction. According to him induction makes a discovery and in colligation we also proceed in that direction of innovating phenomena. Further in induction there is also binding together of facts under a general concept. We observe instances of whales and find them to be mammals. Then we bring the observed phenomena under the complex idea of mammalianness of whales. Because of these important resemblances between induction and colligation whewell treats colligation of facts as the same as induction.

But J. S. Mill presents altogether a different view. He does not accept colligation of facts as an induction. According to Mill colligation should not be treated as induction. For there is no inference or establishment of a proposition in the conclusion. Further simply binding together of facts under a suitable notion or describing them by help of an idea does not explain the facts. But in induction facts are explained scientifically for generalisation. Hence Mill treats colligation as something subsidiary to induction but not proper induction.

The difference between Whewell and Mill over the issue is due to their difference with regard to the nature of induction. While Whewell regards induction as a matter of discovery Mill considers induction as a matter of proof. Further while Whewell gives more stress on the importance of hypothesis in induction Mill adds more stress on the importance of causal explanation in induction. Because of these differences they treat colligation of facts from different angles. But it should be mentioned that all processes which colligate facts are not necessarily induction. For there are different areas like classification, description, definition etc. where facts are colligated, but they are not considered as induction. So Whewell's contention is not correct. Similarly though Mill does not consider colligation of facts as an induction he does it

because of his overemphasis on proof of the conclusion and ascertainment of a causal relation. Mill's contention that a causal connection is proved by the experimental methods is not correct. All inductions do not aim at causal connection, nor is a causal connection proved in induction. So Mill's denial of inductive status to colligation of facts is not on proper ground.

Thus colligation of facts is not induction for it does not possess the essential characteristics of induction. But non-the-less it has great importance so far formation of concepts is concerned. For forming an appropriate concepts is a great exercise in intellectual discourse.

8.4 FALLACIES:

Fallacy means error in reasoning. Every inference involves some reasoning whether good or bad. Logic distinguishes good reasoning from bad reasoning. Logic also analyses the processes and principles governing all inferences. It lays bare the principles of valid inference.

Some logicians use the term fallacy in a wide sense to cover all errors that arise in logical discourses. Sometimes the term fallacy is used in a restricted sense to stand for erroneous inferences only.

It is not possible to classify and name all fallacies in an exhaustive way. Truth and validity may have their criteria but error and fallacy will have no limit. Fallacy has been discussed to guard against the logical errors either in inference or in other areas of logical discourse. Some fallacies are of very common occurrences and some are technical and fall under distinct types.

It has been customary to classify fallacies into two broad areas like deductive fallacy and inductive fallacy. Deductive fallacies are the logical errors, ambiguities or confusions which occur in respect of the subject matter of Deductive Logic about which we shall not be concerned here. But we shall discuss some important types of inductive fallacies that occur in respect of Inductive Logic. Further inductive fallacies, like the deductive ones, are classed as inferential, non-inferential and extra-logical. The important types of non-inferential fallacies arise due to the violation of the rules or procedures connected with observation, hypothesis, explanation, classification etc. Such fallacies have been dealt with in their concerned sections and we shall not repeat them here.

Inferential fallacies arise when the rules of inductive inference are violated. They occur in the areas of causation, generalisation and analogy. Extra-logical fallacies occur due to undue assumption of the premises, erroneous apprehension of the relation between the premises and conclusion etc. Petitio principii, ignoratio elenchi, fallacy of undue assumption are very common extra-logical fallacies. We shall discuss these fallacies and omit those which have already been discussed in different sections.

8.4.1 INFERENTIAL INDUCTIVE FALLACIES:

Inferential inductive fallacies arise when the rules of induction are violated. We have discussed three important types of induction like scientific induction, induction per simple enumeration and analogy. Each of them is governed by certain rules. If any rule is violated there will arise some fallacy. Corresponding to these forms of induction there are fallacies of causation, illicit generalisation and bad analogy.

8.4.2A. Fallacies of Causation:

Cause, we have discussed, is the sum total of all conditions, positive and negative, taken together. Scientifically cause is also the invariable, unconditional and immediate antecedent from the qualitative point of view. When an unscientific view of cause is taken there arises the fallacy of causation. There are various kinds of causal fallacies. We shall discuss some important kinds.

i. Post hoc ergo propter hoc:

Cause is an invariable antecedent but to take any antecedent of a phenomenon as the cause will give rise to the fallacy of post hoc ergo propter hoc. It literally means, 'after this, therefore because of this'. B occurred after A, therefore B must have occurred because of A. To think in this way is to commit this fallacy of post hoc ergo propter hoc. Any antecedent is not the cause of a phenomenon for it does not confirm to the condition of invariability or unconditionally. This fallacy is the source of many suppositions because here no distinction is made between variable and invariable antecedents.

Someone saw a dead body while going to his business establishment. On that day he incurred some loss in business. If he thinks that his loss is due to his coming across a dead body he commits this fallacy of post hoc ergo propter hoc. Or suppose a comet appeared and after two days a national leader died. If the appearance of the comet is considered to be the cause of death of the leader there will arise this fallacy.

ii. Fallacy of mistaking a condition to be the whole cause:-

The cause is the sum total of positive and negative conditions. If one condition is exclusively taken as the whole cause of the phenomenon, this fallacy will arise.

For example, a student failed in the examination. If stiff valuation is considered to be the cause of his failure the reasoning will be fallacious. Because other conditions like his negligence in studies, insincerity in attending his classes, lack of intelligence etc. are omitted. Similarly if we say that tribals are poor because they live in villages we commit this fallacy. Here we concentrate on one condition and ignore other conditions like lack of opportunity, exposure, education, social awareness etc. This fallacy is a very common one in practical life.

iii. Fallacy of non-causa pro-causa:

It means taking any circumstance to be the cause, which is not really the cause. It is like taking a false cause to be the cause. Aristotle illustrated this fallacy in the form of reductio ad impossible. Here the conclusion is something absurd and such absurdity lies in the very assumption of the premise itself. Aristotle's introduction of this fallacy was not considered to be an inductive fallacy. But in modern logic this fallacy is used in a generic sense to connote any causal fallacy. Any fallacy arising in the sphere of causal inquiry is termed as non-causa pro-causa.

iv. Fallacy of ignoring the negative condition:

A cause is constituted by positive and negative conditions. The effect follows when the positive conditions are present and negative conditions are absent. But sometimes negative conditions are ignored and full emphasis is given upon a positive condition. Hard working is meaningless as many hard working people are deprived of the basic requirements of life. Here we are ignoring the negative conditions like exploitation, unfavourable social situation, lack of scope etc.

v. Fallacy of mistaking a remote condition to be the cause

The cause is the unconditional and immediate antecedent. If a remote cause is considered as the cause of the phenomenon under consideration, there arises this fallacy. An antecedent that happened in the remote past cannot be the cause of the effect that takes place at present.

For example, a person's committing a crime at young age is attributed to his uncared childhood. A person might have been uncared in his childhood, but there are other intervening conditions without which he would not have committed a crime at the young age.

vi) Fallacy of supposing the co-effects of a cause as cause and effect.

Different effects might follow from a single cause. If we regard one of the co-effects as the cause of the other effect, we commit this fallacy

Day and night are so related that one follows the other. When we find them to be occurring successively the preceding co-effect is considered to be the cause of the succeeding co-effect. That means day is regarded to be the cause of night and night is regarded as the cause of the day. But day and night are not causally related, i.e. one is not the cause of the other. On the contrary they are the co-effects of a common cause such as rotation of the earth round the sun and its own axix. Similarly suppose a person suffers from high temperature and vomiting. May be they are the co-effects of some

other cause and one is not the cause of the other. But to take one symptom to be the cause of the other symptom is to commit this fallacy.

vii) Fallacy of supposing the effect to be the cause and the cause to be the effect

If we take a cause to be the effect and the effect to be the cause, we commit this fallacy

Sometimes a person's recognition is considered to be the cause of his achievement. But his achievement is the cause of his recognition. When cause and effect are confused and reversed this fallacy is committed.

8.4.3B. Fallacy of illicit Generalisation

This fallacy is committed when we wrongly generalise only observing a few instances. Induction per simple enumeration is based on uncontradictoriness of our experience. The probability of the conclusion depends on the number of positive instances. But hasty generalisation on observation of a few instances or some stray cases leads to this fallacy of illicit generalisation. That means when generalisation is made by observing a few cases in a very limited sphere there is the possibility of committing the fallacy of illicit generalisation.

A person has seen cows in his village to be white. If he generalises that all cows are white, there is illicit generalisation. Or suppose a man comes in contact with a few persons who are otherdox and put on saffron dresses. So he generalises that all otherdox people wear saffron dresses. This is another example of illicit generalisation.

8.4.4C. Fallacy of False Analogy

Analogy is a kind of probable inference based on similarity. It is an inference from one particular to another based on their resemblance. In a false or bad analogy the points of difference and dissimilarity are more in number and importance. In a bad analogy there is no relevant link between the data of comparison and the point that is inferred. For example, two persons come from the same village and belong to the same age group. One of them is an engineer. If we infer that the other person is also an engineer, it will be a case of false analogy.

Fallacy of false analogy, otherwise called bad analogy, has been discussed in the contexts of bad analogy and uniformity of nature.

8.4.5D. EXTRA-LOGICAL FALLACIES:

Fallacy of petitio principii, undue assumption and ignoratio elenchi are included under extra-logical fallacies. Petitio principii means assuming the very point that is required to be proved. It is like arguing in a circle, so it is also called begging the question. What is intended to be proved is introduced into the premise. Suppose one argues that the earth revolves around the sun, because all known planets revolve around the sun. Here the conclusion is assumed in the very premise "all known planets move around the sun" which is an enumerative universal. Thus when the conclusion is assumed in the premise, there arises the fallacy of petitio principii. This concept has been discussed in the context of uniformity of nature in little detail.

The fallacy of undue assumption arises when the premises are wrongly assumed. If the premise is false, then its very assumption will lead to a wrong conclusion. Fallacy of petitio principii also comes under this fallacy. Fallacy of undue assumption admits different forms. Its very common form is the assumption of a wrong premise. Most of the metaphysical speculations are based on this fallacy. Matter is unreal, the world does not exist, motion is impossible are metaphysical assertions. These metaphysical assertions are drawn from undue assumptions of the metaphysicians. A wrong assumption or premise gives rise to a bizarre conclusion.

8.4.2E. IGNORATIO ELENCHI:

Ignoratio elenchi means ignorance to refute an argument. An assertion is refuted when its opposite, either its contrary or contradictory, is established. But in stead of presenting a contrary or contradictory of the conclusion if one proves something else with the impression that the assertion is thereby refuted, then the fallacy of ignoratio elenchi is committed. Aristotle used the term elenchi to mean refutation of an argument by presenting its contradictory through a syllogism.

In the contemporary usage, ignoratio elenchi means arguing irrelevantly or besides the point. If one argues irrelevantly in refuting somebody's contentions, then he commits this fallacy.

So also if one argues irrelevantly in proving his position he also commits this fallacy. The fallacy of ignoratio elenchi admits different forms. We shall discuss some very common types. Understanding these will help to know the troublesome errors in our day today reasoning.

(i) Argumentum ad hominem

The phrase "argumentum ad hominem" means argument against the person. When the thrust of the argument is directed at the person but not against his argument this fallacy is committed. If a person in stead of showing the unreasonableness of his opponent's argument argues against his character or personality, he commits this fallacy. That means an attitude of disapproval towards a person is evoked to refuse his view.

For example, suppose a person speaks against smoking and its bad effects. But without examining the cogency of his view or argument, if someone remarks that the person also smokes and has no right to speak against smoking, he commits this fallacy. Or if we argue that what a man has said must be false because he is a naxalite or that he comes from a disreputed family. Here a conclusion is opposed because the person upholding it is believed to be of bad character or doubtful integrity.

ii) Argumentum ad populum

In stead of arguing on rational ground there is appeal to emotion and passion of the people in this argument. People's sentiment is excited so that they will accept or reject a view without any judicious consideration. Fundamentalists or communalists create communal frenzy among the people to hate people of other religious faith. Advertising agencies appeal to the emotion of the people to purchase their products. These are instances of this argument. Suppose a casteist appeals to the people, caste system should prevail, because our ancestors accepted it. We are definitely not wiser than our ancestors to abolish it. Here there is appeal to the emotion of the people. In stead of examining how far caste system is good or bad, one appeals to the emotion and passion of the people to accept the system. Thus when there is attempt to excite the passion of the

people to favour or oppose some view, there arises this fallacy of argumentum ad populum.

iii) Argumentum ad ignorantiam

This fallacy means argument from ignorance. It consists in throwing the burden on the opponent. A proposition is considered true simply on the ground that it has not been proved false or that it is false because it has not been proved true by the opponent. Taking the advantage of the ignorance of the opponent if someone tries to establish his claim he commits this fallacy. For the claimaint does not give reason for his own argument, but throws the burden on the opponents to disprove his claim.

For example a religious man asks his opponet to believe in the existence of God if he cannot prove God's non-existence. The person does not prove God's existance but asks his opponent to disprove God's existance lest to believe Him.

iv) Argumentum ad Verecundium

Here there is appeal to authority but not to reason. Of course it is not unreasonable to be guided by the knowledge of an expert or authority. If a person is an acknowledged expert in some field we belive his statement and by that we commit no fallacy. An expert's opinion is dependable because he is supposed to have expertised knowledge in some field. Of course his statement is not conclusive as experts also differ at times.

e. But the fallacy of argumentum ad verecundiam arises when there is respect or veneration for a person or some work on some emotional ground. It means if there is no legitimate claim to authority in the matter at hand, then there arises this fallacy. If someone says that caste system should prevail because Manu has supported it in his work called Manusamhita, then we commit this fallacy. Or if it is argued that God is the creator of the universe because religious scriptures say so. This fallacy arises when something is accepted to be true because some greatman or the scriptures say like that.

v) Argumentum ad baculum

This fallacy arises when the opponent is suppressed by physical force. Here the opponent is coerced to accept a view. When rational methods fail, this is used as the last resort. It means might is right. Here a conclusion is insisted upon the opponent by using force either overtly or in a subtle way by applying some trick. In the primitive society things were decided by a duel. Terrorists use force to threaten their opponent. Nations practise it, police use it to make the suspect confess the crime.

vi) The fallacy of non-sequitor or what does not follow

Non-sequitor means what does not follow. It is also called the fallacy of consequent. In a hypothetical proposition there are two parts such as the antecedent and the consequent. The antecedent contains the condition and the consequent contains the result that follows from the antecedent. The consequent can be affirmed when the antecedent is true but not conversely. That means the antecedent cannot be affirmed if the consequent is true. The antecedent and the consequent are not mutually convertible. Let us take an example to illustrate it.

When (if) it rains, the ground becomes wet

The ground is wet

It has rained.

This form of inference is fallacious because the affirmation of the antecedent does not follow from the affirmation of the consequent. For there may be different causes giving rise to the effect. In the above example the ground may be wet due to various other causes. This fallacy is committed if we overlook the possibility of plurality of causes.

vii) Fallacy of Plures interrogations or many questions

Fallacy of plures interrogations means many questions. Some also call it fallacy of complex questions. The question is tricky and posed craftly. If at least two or more questions are

joined together into one and a plain answer, either yes or no, is expected, it puts the opponent in a puzzling situation. For whatever answer he gives will go against him.

Suppose we ask a person, "Have you stopped torturing your wife ?" or "have you given up smoking ?". If the person says "yes", that would justify that he was torturing his wife in the past or that he was smoking previously. If he says "no", then it will prove that he is still torturing his wife, or that he is still smoking. Actually the question is craftly formulated as it contains two questions. In the first case it means he was tortuing in the past and also continuing it. So any single answer will not serve his interest. Hence he should split the question into two parts and deny them separately. He should say that he was neither doing it in the past, nor is he doing it now.

In another form of the argument many predicates are attached to one subject or many subjects are attached to one predicate. In any case a single answer would put the person in a false position.

For example, if it is asked "Is Milan a Brahmin and rich?" If you say "yes" you accept both the predicates and if you say "no" you deny both the predicates. But if one of the predicates is true and the other is false, then the entire answer is false. So you have to answer that he is a Brahamin but not rich or he is rich but not a Brahmin. Unless the answer is given in this way you will be in a false position by wrong implication. So also when there are many subjects of one predicate a similar situation arises.

Are Amar, Akbar and Anthony Indians ?

Any single answer yes or no will put the person in a false position if one of them is not an Indian. So the answer should be precisely given who are Indians and who is not.

viii) Fallacy of hysteron Proteron

The fallacy of hysteron proteron means putting the cart before the horse or putting the last before the first. In the usual logical order of an argument the premise is given first and

the conclusion is inferred from it. This fallacy is explained in the simile of horse and cart. It is convenient to put the horse before the cart so that the horse can pull the cart. But if the order is changed and the cart is put before the horse, no result will come. Similarly if the order or procedure of an argument is changed that will lead to confusion. In an argument if the conclusion is stated first and evidences in support of the conclusion are put there-after that confuses the reader.

Here the confusion is with regard to the order of the argument, but not with the cogency of the argument.

Let us take an example. If one says "The vedas and the Rig veda are the revealed scriptures, so they are holy". In this argument the second part is redundant. If the vedas are the revealed scriptures, so too the Rig Veda for the Vedas include the Rig Veda. So to say the Vedas and Rig veda would be confusing.

ix) Fallacy of shifting the ground

This fallacy is committed when one shifts his stand from time to time. One does not remain firm in his stand rather changes it from time to time to favour his position. Suppose a person charges his neighbour with some offence. But when he fails to justify his charge he shifts his ground and maintains that the neighbor's father was a thief. How can the son of a thief be good. But even if his father was of doubtful integrity that does not justify the misconduct of his son.

Similarly in some argument if a person feels that his position is becoming weak, he shifts the theme to divert the attention of the opponent.

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SUMMARY

Process Simulating Induction

An inference which appears like an induction but is not really so is called process simulating induction. There are three such processes of simulating induction. They are

i) Perfect induction

ii) Parity of reasoning

iii) Colligation of facts

Perfect Induction

It is called induction by complete enumeration. It establishes an apparently general proposition by verifying every instance coming under it.

It is based on observation of facts

There is no inductive leap here.

PARITY OF REASONING:

Whatever reasoning applies to a particular case will apply in every other similar case.

i) It is a deductive form of reasoning and it has nothing to do with observation of facts.

ii) There is no inductive leap here.

COLLIGATION OF FACTS:

It is the act of binding together a set of observed facts by means of a suitable notion. Its characteristics are –

i. It is based on observation of facts.

ii. It has no inductive leap.

iii. It appears more deductive than inductive.

There can be colligration in induction, classification, description and definition.

FALLACY:

Fallacy means error in logical discourse. It is familiarly used in erroneous inferences.

Inductive fallacies are classified as non-inferential, inferential and extra-logical.

Fallacies listed in case of observation, hypothesis, explanation, classification etc. are non-inferential fallacies.

Inferential fallacies arise in case of causation, generalisation and analogy.

Ignoratio elenchi, petitio principii and undue assumption are common extra-logical fallacies.

Some important fallacies of causation are :-

Post hoc ergo propter hoc means after this, so due to this.

Fallacy of mistaking a condition to be the cause.

Fallacy of non-causa pro-causa means failure to recognize the real cause and assume a false cause.

Fallacy of ignoring the negative condition.

Fallacy of mistaking a remote condition to be the cause.

Fallacy of supposing the co-effect of a cause as cause.

Fallacy of mistaking coexistence as causally related.

Ignoratio elenchi means arguing irrelevantly or besides the point. Some important forms are:-

Argumentum ad hominem means arguing against the person.

Argumentum ad populum means appealing to the emotion.

Argumentum ad ignorantium means taking the advantage of the ignorance of the opponent.

Argumentum ad verecundiam means appealing to an authority on emotional ground.

Argumentum ad baculum means suppressing the opponent by physical force.

Fallacy of non-sequitor means which does not follow.

Fallacy of plures interrogations- The question is craftily formulatied and an asswer "yes" or "no" puts the opponent in a baffling position.

Fallacy of hysteron proteron means putting the cart before the horse.

Fallacy of shifting the ground means changing the stand from time to time.

MODEL QUESTION

GROUP – A

Objective Questions:

1. Answer the following:-

i. What is post hoc ergo propter hoc?

ii. Give an example of illicit generalization.

iii. Give an example of petito principii.

iv. What is argumentum ad hominem ?

v. What is argumentum ad populum ?

vi. What is argumentum ad ignorantiam ?

vii. What is argumentum ad verecundiam ?

viii. What is the fallacy of many questions ?

2. Fill in the blanks:-

i. When the conclusion is assumed in the premise, there arises the fallacy of _____.

ii. After this, therefore because of this is known as the fallacy of _____.

iii. When an argument is directed to personal character of the opponent and not to his argument, there arises the fallacy of _____.

iv. If somebody argues appealing to the passion and prejudice of the people, there arises the fallacy of _____.

v. If a conclusion is established taking advantage of others ignorance, there arises the fallacy of _____.

vi. When a conclusion is established with reverence for anthority, there the fallacy of _____ is committed.

vii. When physical force determines a decision there comes the fallacy _____.

GROUP – B

Short Questions:

1. Test of the following arguments and point out the fallacy there in:-

i. All politicians are corrupt since the politicians I have come across are corrupt.

ii. The sun must be moving as it is seen at different points in the sky.

iii. His bad performance in today's examination is due to the fact that he saw a dead body while coming to the examination hall.

iv. Answer 'yes' or 'no'- "have you stopped drinking" ?

v. All religions lead to God as all rivers lead to the sea.

vi. Darwin's theory of evoluation must be wrong as it contradicts the Bible's version.

vii. Your advice on smoking cannot be accepted as you are a drug addict.

2. Explain the following with suitable examples:-

i. Post hoc ergo protier hoc.

ii. Illicit generalisation.

iii. Undue assumption.

iv. Taking a coeffect as the cause.

v. Argumentum ad homineum.

vi. Argumentum ad populum.

vii. Argumentum ad ignorantiam.

viii. Argumentum ad verecundiam.

ix. Argumentum ad baculum.

x. Fallacy of many questions.

xi. What are the processes of simulating induction ?

GROUP- C

Long Questions :-

1. Definite perfect induction. Explain its characteristics.

2. What is parity of reasoning ? Is it deductive or inductive?

3. State and explain the characteristics of colligation of facts ?

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CHAPTER-9
NYAYA SYSTEM

INTRODUCTION:

The sage Gotama is the founder of Nyaya Philosophy. Nyaya Philosophy is known as tarkasastra or the science of arguments or science of reasoning. Nyaya philosophy is primarily concerned with the conditions of correct reasoning and conditions of true knowledge. This is not the sole aim of Nyaya philosophy. Like other systems of Indian philosophy, its ultimate aim is liberation, whch means the cessation of all suffering and pain. In order to attain liberation, knowledge of reality is required. In order to get knowledge, method and conditions of knowledge is necessary. But knowledge of reality presupposes the understanding of what knowledge is, what the sources of knowledge are and how true knowledge is distinguished from wrong knowledge.

NYAYA THEORY OF KNOWLEDGE:

According to Nyaya, knowledge is the manifestion of objects. Just as the light of lamp shows the objects, so also knowlede reveals all its objects knowledge may be valid and (yathartha) invalid (ayathartha). Valid knowledge is presentative and invalid knowledge is representative. Valid knowledge is called a Prama. Invalid knowledge is called aprama. Valid knowledge is difinite, certain and unerring. When I see a book on the table, the book is directly presented before me. I see it directly and I am certain about the truth of its cognition. I have no doubt about its reality and its existence. That is why my knowledge of a book on the table is valid. There are four valid means of knowledge. Perception (Prataksa) inference (Anumana), comparison (Upamana) and testimony (sabda). Knowledge from these sources are valid knowledge.

Invalid knowledge is uncertain, doubtful and erring. So invalid knowledge includes knowledge from memory(smrti), doubt (sansaya), error (viparyaya) and hypothetical reasoning (tarka). Memory is not valid because the object of memory is not presented directly to cognition. Sometimes we perceive a rope as a snake. In the deem light we have doubt about its reality.

Hypothetical reasoning is not a valid knowledge. For example if one arguues "If there is no fire, there cannot be smoke", his argument starts with if. It does not provide us any presentative knowledge rather it is a tarka, because it does not give us any proof of fire, but it takes the help of previous knowledge of smoke or fire, which is uncertian. Let us discuss two of the valid sources of knowledge according to Naiyayikas, i.e., perception and inference.

9.1 PERCEPTION (PRATAKSA)

Nyaya defines Perception as a definite cognition which is produced by sense-object contact and it is true or unerring. The perception of a tree occurs when I see a tree. That means my eyes come in contact with the tree and I am able to see the tree and have the definite knowledge of the truth presented before me. This definition of perception includes ordinary as well as extraordinary perception and excludes inference, comparison & testimony. The sense-object contact necessarily pre-supposes the mutual contact of the sense-organs and the mind (manas). For example, when I see a red rose, my eyes come in contact with the rose and it is decided by mind that it is a rose and its colour is red.

CLASSIFICATION OF PERCEPTION:

Perception is classified into two types: i.e., ordinary or laukika and Extra-ordinary or alaukika. This classification is based on the way which the sense organs come in contact with the object, where the sense-organs come in contact with the object in the usual way, we have ordinary perception. We have alaukika or extra-ordinary perception where the object is not presented to the sense organs but convexed to sense organs through an ususual medium. Ordinary perception is again classified into two kinds, namely external and internal. The external perception occurs due to our external sense organs, like eyes, ear, nose, tongue and skin. Thus we have five kinds of ordinary perception due to our five external sense organs. These five kinds of external perceptions are visual, auditory, olfactory, gustatory and tactual which arise dues to five exernal sense organs. The internal perception is due to the internal sense organ known as mind or manas. This internal perception is known as introspection which means to look within. Internal percption occurs by the perception of internal states and qualities of the soul like pleasure, pain, aversion and willing.

Extra ordinary perception is of three kinds- Samanylaksana, Jnanalaksana and Yogaja. Let us discuss these three kinds of perception.

I) SAMANYA LAKSANA PRATAKSA

It is perception of a Class. A whole class of objects is perceived through the perception of an individual. When I perceive an animal as a cow I perceive the universal cowness in that individual animal. Here our senses come in contact with the objects through its class-character, namely cowness. To perceive the cowness (whch is the essential character of a cow) is to perceive the universal characteristic possessed by all cows . This perception is known as samanya laksana prataksa.

ii) Jnana laksana prataksa

This kind of extraordinary perception is perception of an object through the previous knowledge of an object. In this perception, the sense organs are not in contact with the objects. Here the object is not directly presented to the sense organs. The object was perceived in the past and the past remembrance is retained in the memory. This memory helps in organising the object present before us to be the object as seen in the past. For example, we perceive a piece ice from a distance and say "Ice looks cold".

Another example of it is "the cotton looks soft". But it is not possible to see coldness of ice, because coldness is something is felt by touching through our skin. I am perceiving the coldness of ice by visualising the ice. Here the visual perception is associated with tactual perception, which was perceived in the past. This process is known as Jnana laksana Prataksa.

iii) Yogaja Prataksa

The third kind of extra ordinary perception is Yogaja prataksa. It is a kind of intuitive perception of all objects of past and future. This kind of perception is possible on the part of the persons who possess some super natural power generated in the mind. This super natural power is created by the Yogis in meditation. A Yogi or a mystic can perceive all objects through meditation, which is not possible for ordinary perception.

Indeterminate & Determinate perception(Nirvikalpaka and Savikalpaka Prataksa)

According to another classification perception is devided into two kinds; indeterminate (Nirvikalpaka) and determinate (Savikalpaka). But nyaya considers indeterminate and determinate are not two different kinds of perception, rather, these are only two stages of perception, namely,

the earlier & the later stage of perception. Indeterminate perception arises immediately after the sense-object contact. It is the immediate awareness/ apprehension of an object without stating the name of the object. This type of perception is completely free from assimilation discrimination, analysis and synthesis of its qualities. For example, when you percive a mango on the table you cognise it as a mango. At the first glance, apprehend something on the table, its colour, shape etc. without general character of mango. It is indeterminate perception. You are not concerned with qualities of the mango. But when you recognise it as a mango with relation to its qualities, it is determinate perception. The indeterminate & determinate are only two stages of perception.

9.2 INFERENCE (ANUMANA)

In the Indian philosophical tradition attempts have been made to reach at the right knowledge by the application of proper method of knowing. Almost all the schools of Indian philosophy accept anumana(inference) as a logical way of arriving at the right knowledge.

The Nyaya system is known as the pramana sastra, that helps in obtaining right knowledge(prama). In Nyaya system we find there is extensive study about reasoning (tarka). In this system four independent mehtods of knowing are accepted. Inference(anumana) is one of them. Similarly in Buddhistic system inference is accepted as a source of right knowledge. For them inferences involve arguments. Vedantins too have shown inference as a method of reaching at valid conclusions. Thus most of the systems of Indian Philosophy accept inference as a source of knowledge. In this chapter Nyaya method of inference will be discussed in brief.

The study of inference includes the study of the form of the arguments and the basis of reaching at the conclusion. The form of the argument is understood as the step through which the conclusion is reached. For example, Naiyayikas accept five steps to reach at the conclusion. So their form of the argument consists of five steps. Regarding the basis of reaching the conclusion, vyapti is accepted as the basis. Thus it is necessary to know what are the steps involved in reaching the conclusion and on what ground vyapti is accepted as the basis of the inference.

FORM OF THE ARGUMENT IN THE NYAYA SCHOOL OF THOUGHT :

The Nyaya argument is pancavayavi in the sense that it has five steps. Those are namely, pratijna, hetu, udaharana, upanaya and nigamana.

EXAMPLE OF AN ARGUMENT:

1. Pratijna - The hill has fire.

2. Hetu - Because it has smoke

3. Udaharana - Whatever has smoke has fire.

4. Upanaya - This hill has smoke which is invariably associated with fire.

5. Nigamana - Therefore, this hill has fire.

Here the presence of the fire has been inferred from the presence of the smoke through five steps. The steps involved are in this following order.

a) What is to be proved.

b) The reason for what is to be proved.

c) Example.

d) Application of universal concomitance of present case.

e) The conclusion.

THE FEATURES OF THIS ARGUMENT:

i) The last three steps have similarity with Aristotelian pattern of syllogism. It is in the form of AAA(Barbara) of the Ist figure.

ii) It has three terms very much like the classical syllogism. They are, Sadhya(corresponds to the major term), Paksa(corresponds to the minor team) and Hetu or Linga(corresponds to the middle term).

iii) The fourth step synthesizes all the three terms together. This synthesis is called linga paramarsa. The relation between paksa and sadhya(the two extreme terms) is decided on the basis of their relation with the middle term (hetu).

iv) The basis of drawing the conclusion is the relation of vyapti which is expessed in the third step. It is the nerve of inference. Vyapti expresses, the relation of universal concomitance between sadhya and hetu.

v) Some logicians consider the first three steps to be in the form of an induction, specially of scientific induction type. In this sense, in the Nyaya form of argument both the inductive and deductive patterns are said to be blended together. But it is a case of reaching a particular premise through a general statement,(particular to particular through general, neither from general to particular nor from particular to general)

Even though some hold the view that Nyaya form of argument is both inductive and deductive by nature, the correct view seems to be that Nyaya argument is exclusively inductive like that of the case of scientific induction.

9.3 VYAPTI:

Vyapti is considered as the ground of inferences. The conclusion cannot be inferred logically without the knowledge of vyapti. Vyapti is expressed by the help of a general or universal statement. This universal statement expresses the relation of constant concomitance (Niyata sahacarya) between the middle term(hetu) and the major term(sadhya). In other words vyapti implies the knowledge of invariable relation of causality or co-existence(sahacara) between sadhya and hetu(in all the past, present and future instances). Such a knowledge is possible when we know that there is the relation of unconditionality (anupadhik sambandha) between the two. Thus vyapti has been defined as the unconditional and constant concomitant relation between vyapya and vyapaka (pervaded and pervader). In the example of the five stepped argument discussed earlier, the third step ascertains the relation of vyapti. It is essential for any inference in the Indian logical pattern.

9.3.1 ASCERTAINMENT OF VYAPTI:

The law of uniformity of nature is considered as one of the formal grounds of induction. The question is raised how do we get the knowledge about this law as it is itself a case of inference. This problem is known as the problem of induction.

A similar problem is raised in the context of vyapti, which is considered as the ground of inference. The vyapti is the basis of reaching at the conclusion. But how do we ascertain vyapit?

To this important question, Naiyayikas, Buddhists and Vedantins have given answers in the following manner.

9.3.2 a) THE VIEW OF NYAYA

Naiyayikas have suggested that the invariable, unconditional, constant concomitant relation can be established through six ways, those are, namely, anvaya, vyatireka, vyabhicaragraha, upadhinirasa, tarka and samanya laksana pratyaksa.

i) **Anvaya-** Anvaya refers to the cases of experience of the positive instances where the constant concomitance between the two (vyapya and vyapaka) has been witnessed. Here the knowledge is obtained through the knowledge of agreement in presence. It is just like Mill's method of agreement that helps us in knowing the causal relation between two phenomena. Once the causal relation between two phenomena is established it can be expressed in a general statement. Thus Vyapti can be ascertained through the experience of the positive instances of causal connections between two events. Wherever smoke is seen there fire is also seen or wherever cloven hoofs are experienced there the presence of horns is also experienced.

ii) **Vyatireka -** Vyatireka refers to such cases where the absence of one also decides the absence of the other phenomenon on a number of occasions. It is like the method of difference. It helps in arriving the causal connection. e.g. wherever fire is absent smoke is also absent.

iii) **Vyabhicaragraha -** This step refers to the non-observation of contrary instances. It helps in strengthening the knowledge obtained through anvaya or vyatireka. If a single case of presence of the smoke and absence of the fire is not experienced it helps in reaching the general statement: wherever there is smoke there is fire.

iv) **Upadhinirasa-** This step puts emphasis on the relation of unconditionality. The sadhya and hetu are to be related unconditionally; a condition is known as upadhi. The absence of the condition helps us in knowing the invariable relation between two phenomena. The invariable relation leads to universal relation. Repeated observations help in arriving at the knowledge of unconditionality.

Smoke is produced when the fuel is found to be wet. This is not a condition to relate smoke with the fire. This is a condition to relate fire with the smoke. All cases of fire are not smoky. Only those cases of fire, where the fuel is wet, are smoky. Thus smoke and fire are unconditionally related but not the fire and smoke. Because all cases of fire are not the cases of smoke. In other words there can't be smoke without fire, but there can be fire without having smokes. So smoke is unconditionally related to fire.

v) **Tarka -** Tarka refers to hypothetical reasoning . The relation of concomitance should be supported properly by some reasoning (tarka). There are certain cases where reasoning helps us reaching general statements. A generalization is established with more certainty through an indirect method of showing the impossibility of opposite tarka or reasoning. The opposite tarka would be some cases of smoke are not cases of fire. On this basis it is concluded that "All smoky objects are fiery".

The causal connection between smoke and fire is accepted because we cannot assume that where smoke is present fire may be absent.

vi) **Samanya laksana Pratyaksa -** In all the previous steps attempt has been made to establish causal connection between two events basing on particular instances. But such a relation can also be confirmed looking to their class-characteristics. Naiyayikas have advocated in suport of samanya laksana pratyaksa which is the perception of the universal element. The class-character aims at the fundamental nature of the thing. The general characteristic of smoke is that it comes out of some fiery object. It can't come out of non-fiery object. Thus the smoke class and the fire class are related on the basis of which a universal statement can be established. Similarly out of the death of so many human beings, the perception of the causal connection between manhood and the mortality can be made. That is another example of samanya laksana pratyaksa.

9.3.3 IN THE VIEW OF LATER BUDDHISM:

Like Nyaya, the later Buddhists gave utmost emphasis on the causal relation for making an inference. Buddhists consider that if five conditions are seen between two phenomena, then they are accepted as causally related. On the basis of such causal connection vyapti can be ascertained. Here there is the need of a universal statement which serves as vyapti for inference. There can be no valid inference without vyapti.

If the causal connection between the smoke and the fire is established through the method of Pancakarani(five causal conditions), then the cause can be inferred from the effect logically. Thus Buddhist logicians follow five steps in the form of panca-karani in the following manner to establish the causal connection and vyapti.

i) When the cause is not present, the effect is also not present (In absence of fire, smoke does not appear)

ii) Cause is present (we observe fire)

iii) The effect succeeds the cause immediately (smoke is perceived immediately)

iv) The cause disappears (the fire is extinguished)

v) The effect also disappears (the smoke disappears)

To ascertain vyapti the Buddhists rely on the law of causation. Their argument is very much like in the pattern of scientific causation. The conclusion is drawn by the help of a general premise which is obtained through the law of causation. The general premise serves the purpose of vyapti in this form of inference. Thus vyapti also plays a vital role in the Buddhistic form of inference.

9.3.4 IN THE VIEW OF VEDANTA:

In the Vedantic view, the vyapti is also considered as essential for any inference. The vyapti states an invariable and unconditional relationship between two terms. The Vedantins follow the method of repeated observations of concomitant relation and non-observation of contrary instances. (vyabhicaradarsana sati sahalara darsanam) in order to establish the relation

of vyapti. That is why they donot claim the possibility of necessary relationship between the vyapya and vyapaka. The relation vyapti, according to Vedantins, is only contingent or probable in nature. Through the varieties of observations the vyapti is ascertained with more certainty but not with absolute certainty.

9.4 FALLACIES CONCERNING HETU

The fallacy concerning hetu is known as hetvabhasa. If the hetu does not provide sufficient ground to justify the conclusion, then hetvabhasa is committed. Hetvabhasa thus signifies fallacious reasoning. Five such material fallacies are possible. Those are:

1. Savyabhicara or the irregular middle, when the hetu is not invariably related to sadhya, the conclusion is likely to be false.
2. Virudha when the hetu is not related to sadhya but to its contradictory, this fallacy arises.
3. Satapratipaksa when the conclusion can be contradicted by another hetu justifying the opposite of the conclusion, this fallacy arises.
4. Asidha this fallacy arises when the hetu has not been proved in the premises such a fallacy takes place.
5. Badhita when the conclusion brought out by hetu is disproved by some other praman, this fallacy arises.

9.5 TYPES OF INFERENCE:

The Nyaya logicians classify the inferences in many ways.

1. Basing on the factor, for whom the inference is meant for, inferences are classified into two types, namely, svarthanumana and parartha anumana.

   Svarthanumana is meant for the person himself. If I make some inference for me, then there is no need of a detailed logical procedure. Three steps are sufficient to arrive at the conclusion. I can say, for example -

   1. The hill has smoke.
   2. All cases of smoke are cases of fire.
   3. ∴ The hill has fire.

Parartha anumana is the inference made for others. So it has to be placed in its perfect logical order. The five stepped argument discussed earlier is the example of a paratha anumana. It is panca-avayavi.

2. From the standpoint of nature of vyapti, inferences are classified into three types. purvavat, sesavat, samanyatodrsta.

a) **Purvavat-** When the unperceived effect is inferred from the perceived cause it is a case of purvavat inference. When we infer good harvest from the timely monsoon, it falls in purvvat category.

b) **Sesavat-** When the unperceived cause is inferred from the perceived effect it is a case of sesavat inference. The inference of rain in the last night by looking to the muddy road in the early morning we have sesavat inference.

c) **Samanyatodrsta-** This inference is not based on the knowledge of causal relation rather on the relation of co-existence. Basing of the relation of co-existence the presence of one can be inferred from the presence of the other. Form the fragrance of jasmine flower one can infer the presence of the jasmine flower is a case of samanyatodrsta inference.

3. From the standpoint of the method of ascertaining vyapti, inferences are classified in to three types. They are

a) **Kevalanvayi (Agrement in presence)**

In this type of inference the universal relation vyapti is established between the middle term and the major term on the basis of a number of positive instances. The conclusion is arrived at on the basis of the presence (anvaya) in agreement. This resembles with Mill' method of agreement. e.g. All knowable objects are namable.

The table is a knowable object.

$\therefore$ The table is a namable object.

b) Kevala vyatireki(agreement in absence)

In this type of inference the universal relation vyapti is established between the middle term and the major term on the basis of agreement in absence i.e. the middle term is only negatively related to the major term. This resembles with Mill's method of difference. For example :-

No non-fiery object is smoky.

The hill is smoky

∴ The hill is fiery.

c) Anvayavyatireki- When the middle term is both positively and negatively related to the major term, it is a case of anvayavyatireka inference .

Here vyapti is ascertained through the agreement in presence and agreement in absence. This resembles with Mill's joint method of agreement and difference. For example :-

All smoky objects are fiery.

The hill is smoky.

∴ The hill is fiery

No non-fiery objects are smoky

The hill is smoky.

∴ The hill is fiery.

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SUMMARY

NYAYA THEORY OF PERCEPTION (PRATAKSA)

Perception is a kind of definite cognition which is unerring. It is true and comes in contact with sense organs. It is presented before our sense organs. Perception occurs when our sense organs come in contact with the object.

Perception is classified into two types, ordinary and extra-ordinary. (Loukika or alaukika). When our sense organs come in contact wth the objects in the usual manner, is called ordinary perception. We have extra-ordinary perception when the objects are not presented before the sense organs but conveyed through an unusual medium. Again ordinary perception is of two types;, is internal and external. Internal perception occurs by our mind. The external perception occurs through our ordinary sense organs.

Extra ordinary perception again is classified into three types, i.e.; samanya laksana prataksa, Jnana laksana prataksa and Yogaja prataksa.

From another point of view perception can be divided into indeterminate and determinate perception. But Naiyaikas never consider it to be two different types of perception, rather two different stages of perception.

NYAYA THEORY OF INFERENCE (ANUMANA):

The form of the argument has five steps(panca avayabi). The basis of drawing the conclusion is vyapti. The vyapti is the relation of constant concomitance between hetu and sadhya. The vyapti is the nerve of inference expressed in a universal statement. Naiyayikas provide six grounds for the ascertainment of vyapti. Later Buddhist logicians attach maximum emphasis on the causal relationship for the ascertainment of vyapti. Vedantins have accepted the relation of vyapti to be contingent instead of being a necessary one. They follow the method of repeated observations for the ascertainment of vyapti.

There are five types of fallacies (Hetvabhasa) They are - savyabhicar, viruddha, satpratipaksa, asidha and badhita. Inferences are classified in many ways.

According to one classification inferences are of two types

i) Svarthanumana- Inference for the self. (3 steps)

ii) Pararthanumana- Inference for others.(5steps)

According to another classification(Nature of vyapti) inferences are classified in to three types.

i) Purvavat- unperceived effect from perceived cause.

ii) Sesavat- unperceived cause from perceived effect.

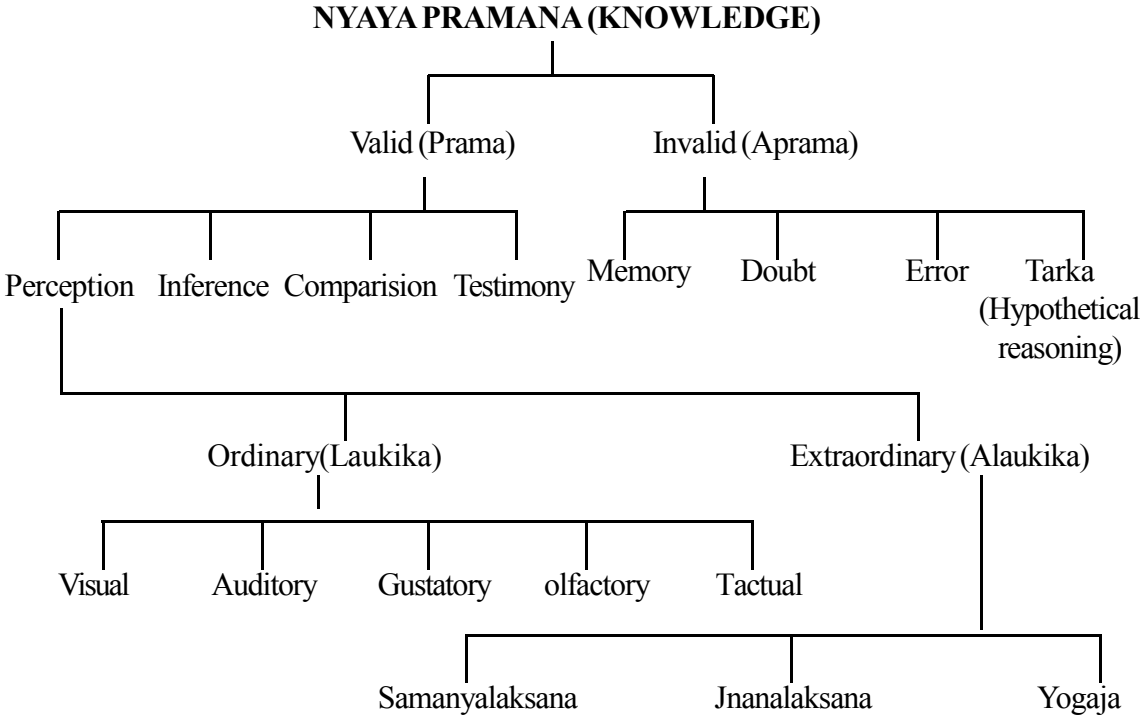
iii) Samanyatodrsta- when inference is based on the relation of co-existence.

According to another classification(method of ascertainment of vyapti) inference are of three types.

i) Kevalanvayi- agreement in presence. (like Mill's method of agreement)

ii) Kevala vyatireki- agreement in absence (like Mill's method of difference)

iii) Anvaya vyatireki- Agreement in presence and absence. (like Mill's joint method of agreement and difference)



MODEL QUESTION

1. Objective questions:

a) Who is the founder of Nyaya System ?

b) What are the valid sources of knowledge according to Nyaya ?

c) Give one example of source of invalid knowledge.

d) What do you mean by introspection ?

e) How many kinds of extra ordinary perceptions are there in Nyaya System ?

2. Fill in the blanks:

a) The valid knowledge is known as _____.

b) The invalid knowledge is known as _____.

c) Memory is a kind of _____ source of knowledge.

d) Perception is a kind of _____ source of knowledge.

e) Ordinary perception is classified into _____ and _____.

f) Extraordinary perception is classified into _____, _____ and_____.

g) Error is a _____ source of knowledge.

3. Write short notes on:

a) Yogaja Prataksa

b) Internal perception

c) Valid knowledge

d) Jnana loksana prataksa

e) Nirvikalpaka prataksa

f) Savikalpaka prataaksa

4. Distinguish between

a) Valid & invalid knowledge

b) Internal & external perception

c) Determinate & Indeterminate perception

5. Long Questions:

a) What are ordinary perceptions ? Exaplain.

b) What are extraordinary perceptions ?

c) Explain Nyaya theory of perception briefly.

MODEL QUESTIONS

GROUP - A

Objective Questions:-

1. Answer the following :-

a. How many propositions are there in an inference according to Nyaya ?

b. What are the corresponding names in Nyaya terminology for major term, middle term and minor term ?

c. State the definition of vyapti.

d. State the names of two steps for the ascertainment of vyapti.

e. What is bhuyodarsana?

f. What is vyabhicaragraha?

2. Fill in the blanks :-

a. In an inference the major term is called _____ in Nyaya terminology.

b. Vyapti means the invariable concomitance between sadhya and _____.

c. There are two kinds of vyapti, such as samavyapti and _____.

d. Anvaya means agreement in _____.

e. According to one classification inference may be purvavata, sesavata and _____

3. Short Questions

Write note on

a) Panca karani.

b) Anvaya

c) Anvaya vyatireki

d) Samanya laksana perception.

e) Vyapti

f) Name the fallacies of inference.

4. Distinguish between.

a) Samavyapti and a visama vyapti

b) Svarthanumana and pararthanumana.

c) Kevalanvayi and Kevalavyatireki.

d) Purvavat and sesavat inference.

Long Questions:

1. What is the procedure of inference in Nyaya system?
2. What is vyapti ? How can it be ascertained?
3. Compare the later Buddhistic views on vyapti with the vedantin view.
4. Compare the Nyaya theory of inference with that of the Western method.
5. Discuss the different ways of classification of inference according to Nyaya..

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CHAPTER-10
INDIAN ETHICS

10.1 DOCTRINE OF KARMA

NISKAMA KARMA OF BHAGAVAD GITA

Bhagavad Gita : An introduction

The Bhagavad Gita is an ancient classic text originally written in Sanskrit. It is considered as a sacred Book of the Hindus. it constitutes one of the three foundations (Prastanatrai) of Hindu religion with the Upanisads and Brahmasutra as the other two. The Gita literally means the songs celestial. To treat the Gita as a religious classic is to miss the real import of the text. More pertinently the Gita can be treated as a philosophical treatise. It is written by Sage Vyasa the legendary compiller of the Mahabharata. The Gita constitutes a part of the epic Mahabharat. It contains 18 Chapters, i.e., (Chapter-23-40) of the Bhisma Parva of the Mahabharat.

The Gita is a spiritual dialogue between Lord Krishna and Arjuna. The setting of it, is the battle field of Kurukhetra, where the historic battle was faught between the Pandavas and Kouravas over the issues of family disputes. Having seen his own relatives, friends, teachers and olders in front of him Arjuna was overwhelmed with grief and then refused to fight. He is in a moral dillema. In order to dispel the fears and delusions of Arjuna, Srikrishna tells Arjuna the eternal words of wisdom that are recorded in the Gita. In present form, the Gita contains 700 slokas or verses arranged in 18 chapters.

Niskama karma:

The Gita is not merely a book of theories and doctrines, nor it is merely a piece of ancient literature. It is rather a practical guide to the art of living, a yoga-sastra which teaches us how to

make our life full, serene and happy. The Gita opens up vast and profound vistas of spiritual life for a man who allows it to influence his thought and conduct. The colophon at the end of each chapter describes theGita as Yogasastra. Being Yogasastra the Gita's message is Yoga. The Gita defines 'Yoga' as 'Samatvam yoga uchyate' i.e., evenness of mind. Thus Yoga is the state of equanimity of mind by attaining which one finds no dualities and differences between one and the others. Yoga again is defined in the Gita as Yogah karmasu kousalam' i.e. Yoga is the skill in action. Here Yoga implies that one has to perform his action with perfect knowledge of the reality without any attachment for result. In the context of the Gita the supreme Reality which is nothing but the supreme knowledge rests on three presuppositions, such as (i) The supreme reality (Purusottama) is the ultimate designer, the agent and enjoyer of all actions. (ii) The purusa or human being is the instrument in the hands of the Lord to fulfill the divine end. (iii) We have to accept the design and to transcend the limits of ordinary morality through niskama karma to attain the state of naiskarmya.

The karmayoga or the doctrine of niskamakarma which constitutes the rock bottom of the Gita's ethics needs to be discussed in detail. Arjuna being puzzled, what to do and what not to do asks Srikrishna, 'sadhi man tvam prapannam', means I have taken refurse in you, please instruct me. After listening to the Lord's discourse, he responds with the following words, 'karisye vachanam tava' means, I shall do as you bid me. Acharya Sankara has emphasised on two goals of the Gita i.e., abhyudaya and nisreyasa, taking the concept of dharma as defined by kanada as "yato abhyudaya nisreyasa siddhi sa dharma". Now let the logic of niskamakarma be discussed on the basis of above three presuppositions and two goals of the Gita. Abhudaya means upliftment of both, the individual and the society. By the practice of niskamakarma, human beings transform themselves form ordinary level to the spiritual level, which ultimately brings social upliftment i.e., upliftment of fellow beings. Nishreyasa means spiritual freedom i.e., the end or the ultimate goal, which can be attended by the means of niskamakarma.

The Gita aims at to bring sanity and clarity to the confused minds like Arjuna (all of us) and enables one to develop spirituality through Yoga. The Gita acknowledges various types of Yogas

out of which karma yoga, jnana yoga and bhakti yoga have not more significance for the spiritual progress which have been conceived as complete and independent methods of reaching the goal. Karmayoga advocates that actions performed with right knowledge liberates whereas action performed with ignorance binds. In the world of existence there is a constant play of preya (desireable) and sreya (preferable). So our ordinary moral life is controlled by the operation of the karma doctrine 'as you sow, so shall you reap', as the world itself is the expression of the constant play of doership (kartrtva) and enjoyership (bhoktrtva). Karmayoga exclusively instructs us to perform actions including rites and ceremonies in a spirit of detachment (nivrti) with no attachment for result. All actions of karma yogi have a single aim i.e. the unfoldment of his spiritual nature.

Besides the obligatory actions like nitya and naimitaka karma and spontaneous actions called sahaja karma, the Gita also distinguishes between karma, akarma, vikarma and naiskarmya. The karma referes to all actions of body, mind and speech. Vikarma means all prohibited or evil actions. Akarma in fact referes to the ideal action i.e., niskama karma in the Gita. It does not mean karma sanyasa or renounciation of action. Rather it means action performed with total non-attachment for the result. The a-karma or akarma is the action performed with self-knowledge. It is a state where the distinction between action and inaction disappears and becomes an inflinching offering to the Lord. Thus akarma is performed with the knowledge of discrimination, with a motive for the betterment of the society without any selfish desire for its fruits which can rightly be called niskamakarma. Sankar explains akarma as nivrtti in action while Ramanuja interprets it as atmajnana. There can be philosophical debate on these.

Naiskarmya on the other hand refers to the highest state of non-action or inactivity. Radhakrishnan interprets it as freedom from action. For Aurobindo "Naiskarmya is a calm voidness from works, is no doubt that to which the soul, the purusa has to attain". It is the end in itself. It is the highest state of yoga. Niskamakarma is the means which leads one to the consummation of naiskarmya.

The Gita does not preach passivism. One can not but to perform action, because no one can ever remain even for a moment without doing an action. Abstention from action is not possible because the very existence of physical body which consists of gunas, necessitates action on the part of the individual. So also abstention from action is not desirable because one does not attain freedom from action nor does he attain fulfilment merely through renunciation. Thus it is through action one is led to akarma or niskamakarma which in turn leads to naiskarmya or the highest state of yoga.

Here we find a riddle in the phenomenon of action. The action has its own reaction. So the doer of action is bound to reap its consequences which may be pleasant or painful. Action thus leads to bondage. On the other hand it is the means through which is to attain the state of Yoga. So the riddle: to act is to be in bondage, but by act only one gets liberated. This riddle is solved by the niskamakarma of the Gita by pointing out that, the action neither binds nor liberates. It is the ideaction behind the action binds or liberates.

Ordinarily an action has three distinguishable components, agent, action and the object. In performing an action the agent has a particular end in view i.e., certain consequence to achieve, which is called sakamakarma. But in niskamakarma the agent performs an action with least attachment or no regard for the consequences. So it is desireless action.

Here a possible oddity appears. One might ask how can there be an action without any motive ? All actions are backed by the voliltion on the part of the agent. Even the very desire for spiritual freedom or liberaction is non the less a desire. Desireless action is so to say an impossibility. To understand niskamakarma in the above sense is to miss the very import and significance of the concept. An action has two distinguishable components (i) the action itself, (ii) the consequecnes. The Gita says one should have right to 'action' but not to the 'consequences'.

"To action alone hast thou a right and never at all to its fruits; let not the fruits of action be thy motive; neither let there be in thee any attachment to inaction.

In response to such possible doubt, one has to understand the significance of niskarmakarma which is a path to 'Yoga' and thus falls beyonds the scope of action-consequences nexus. Thus the Gita does not discard the action rather teaches the secrets of suspending doership which is the root of our egoistic desire for the fruits of action. When one thinks himselfs as the doer, the consequences of the act, be good or bad, one appropriated to himself. One feels elevated or dejected depending on the nature of the consequences. So the Gita teaches the secret of suspending the sense of doership by considering oneself as a mere instrument in the hands of the reality. According to the Gita the real doer is the Lord Himself - the Purussottama. The individual is just a cog in the wheel, an instrument (nimittamatra) who does the work on his behalf by his natural endowment i.e., 'svabhava' for the maintenance of the cosmic order.

When one withdraws oneself from the doer-deed nexus, one has no reason to feel elevated or dejected at the sight of the consequences. He then is established in the state of equanimity and called 'stitaprajna' which is precisely be called the state of Yoga or naiskarmya. Thus niskama karma does not mean renunciation of action but renunciation in action. In otherwords, it is not karma tyaga but karmaphalatyaga. The Gita describes this idea repeatedly in various verses such as 'ma phalesu kadacana', 'phalam tyaktva manisinah'', 'sarva karma phala tyagi' etc.

It is only the niskamakarma where one does not remain bound to the consequences of his actions. He rather remains beyond the limits of moral valuation. Because it is a trans-ethical state, where the polarities of good and bad cease to have any meaning. Therefore the Gita says, "therefore always perform action without any attachment. For a man attains the supreme perfection, by performing actions without attachment.

All karmas turn out to be niskarmakarma provided they are performed with right ideaction. That's why Arjuna is being asked by Srikrishna not to perform action in the usual way, but to act being fixed in Yoga "Yogasta kuru karmani. Yoga which consists in acting with perfect equanimity where the yogin is quite indefferent to the result of the action. (samatvam yoga uchyate).

Again niskamakarma is to be performed in the sense of yajna or veritable offerings to God. Because the God is the real agent or the supreme person on whom behalf we act as an instrument in his hand. So whatever be the consequence that is offered to God. Yajna in the sense of sacrifice is also equated with niskamakarma.

Niskamakarma presupposes right knowledge or knowledge of discrimination between self and not-self. For a niskamakarmi all actions are performed with the ultimate end in view i.e., jnana. Right knowledge consists in seeing action in inaction and inaction in action. Thus by niskamakarma visayakarma is transformed into atmakama (self-knowledge).

Now one important question is, can a moral agent be completely detached ? Can an action, not prompted by any desire be action proper ? The Gita answers altogether from a new perspective. According to the Gita one should act for the maintenance of dharma, the cosmic moral order. If moral valuations involve choice and free will then the moral agent has to be a participant in the moral process. Now the question arises why does he act and what is the right course of action ? The answer is, the only incentive for action would be 'lokasangraha' the welfare of all which is otherwise called nishreyasa or spiritual freedom. With this incentive the moral agent becomes a sage whose mind is steady in the midst of sorrows, free from anger, desire, passion, amid pleasure and with settled intelligence. Thus a niskamakarmi is one who has banished all his desires and who withdraws his sense from the object of sense like a tortoise draws in his limbs.

Niskamakarma is thus for self-fulfilment. Self-fulfullment can be achieved only when our svadharma i.e., outward life and svabhava i.e., inner life answer to each other. Then only the action will free easy and spontaneous and thereby one will live in the God's world i.e., in perfection or in highest spiritual wisdom.

SUMMARY:

The Bhagavad Gita is an ancient classical text is considered as sacred book of Hindu Religion. It is written by Sage Vyasa. It is a part of mahabharat story. It is a spiritual dialogue between Lord Srikrishna and Arjuna. It is not only theoretical doctrine rather it is a practical guidance to the art of living, a yoga sastra that teaches us how to make our life peaceful and happy.

Doctrine of Karma is mentioned in karma yoga of the Gita. The Karma yoga or the doctrine of niskamakarma which as the rock bottom of the Gita's ethics. The logic of Niskamakarma is discussed on the basis of three presuppositions and two goals of the Gita. The Gita acknowledges various types of yogas out of which karma yoga, Jnana yoga and bhakti Yoga have got more significance for spiritual goal. Karma Yoga advocates that actions performed with right knowledge liberates a man. Karma has been classified as karma, akarma vikarma and naiskarmaya. Akarma refers to ideal action i.e., niskanakarma. Gita does not explains karmasanyasa or renounciation of action. Rather it is an action performed with total non-attachment for result, thus akarma is performed with the knowledge or discrimination, with a motive for the betterment of the society without any selfish motive. Niskamakarma is performed in the sense of Yajna for the God, because God is the real agent. A karma yogi feels himself, not an agent rather an instrument in the hands of Lord Krishna. So he has to leave his doership(kartvabhava). The action is perfromed for the welfare of the society i.e., lokasangraha.

MODEL QUESTIONS

1. Objective type answers.

   a) Who is the author of Bhagavad Gita ?

   b) How many chapters are there in the Bhagavad Gita ?

   c) How many types of karma are mentioned in Gita ?

   d) What is the meaning of akarma ?

   e) What is the meaning of vikarma ?

2. Fill in the blanks.

   a) The Mahabharat war was between _____ and _____.

   b) The dialogue of Gita is between _____ and _____.

   c) Preya means _____.

   d) Sreya means _____.

   e) Sankara explains akarma as nivrtti while Ramanuja interpretes it as _____.

3. Short answer type (2 to 3 sentences)

   a) Pravriti

   b) Naiskarmya

   c) Naiskamakarma

   d) Karmasanyasa

   e) Lokasangraha

4. Long question

   a) Explain the doctrine of Niskamakarma of the Bhagavad Gita;

   b) Explain karma, akarma and vikarma in the light of the Gita.

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10.2 GANDHIAN CONCEPT OF NON-VIOLENCE:

Introduction :

Mahatma Gandhi was philosopher, a political scientist and a social revolutionary in the history of the World. He was not a Philosopher in the technical sense but he is a Philosopher in practice. He was deeply intersted in making practical philosophy of human being and Philosophy of Life. He also presupposes the metaphysical foundation of Philosophy of life i.e., the nature of man, God and Universe. Gandhi is one of the Philosophers who provides an unique technique to change the world. Pure thought leads to pure action, so Gandhi brings out a necessary connection between theory and practice. He is a novel philosopher who tries to give a practical application to the concept of Truth, Non-Violence, Satyagraha and Savodaya.

Non-Violence :

The word non-violence ordinarily means 'Ahimsa'. Ahimsa means non-injury. Non-injury is a manifold concept which can be interpreted in various ways. We find in most of the Indian traditions like Jainism, Budhism, ahimsa is taken as one of the ethical principles. That is why Jainas show their kindness even to the small insects. But Mahatma Gandhi has not only confined Ahimsa to non-killing or non-injury to animals but also extends to the whole mankind. Let us discuss some of the significances of basic ideas of non-violence offered by him.

Ahimsa has been taken in two sense i.e., in a positive sense and in a negative sense. He considered Ahimsa not only in negative sense of non-killing or non-injury but has also taken a positive stand of considering it in the form love or compassion. Love does not mean to love or compassion for people belonging to a particular religion or section, but it is considered as a cardinal principle, a moral law. Ahimsa stands for boundless love for all irrespective of caste, creed, color, sect, religion etc.

According to Gandhi, every person is a spirit or a soul. His metaphysical model of man is the soul or the spirit behind every human being. Non-violence is not only confined to the body, but also to the soul. For Gandhi love not only gives pleasure but it also involves endless patience

and deliberate self-suffering. Love never claims or expects anything in return. Therefore, the essence of love is self suffering and enjoyment. One finds pleasure in self-suffering and sacrificing for others. Sacrifice is an indispensable part of love. Such love is possible when one adopts self-suffering which means true and infinite love. Gandhi in all practical means defines love and compassion as doing positive good for others at the cost of self-suffering. Thus Gandhi says:

"Ahimsa really means that you may not offer anybody, you may not harbour an uncharitable thought even in connection with one who may consider himself to be your enemy."

It is not merely love that signifies the meaning of non-violence, but the concept of non-violence also stands for cardinal principle of life that governs the entire human community. In other words, non-violence is both law of love and law of life. According to Gandhi, a true non-violent person accepts violence on himself without inflicting it on another. Identifying love with ahimsa he says that if you have love towards somebody and you respect that person, then you are not going to do any harm to that person. Gandhian concept of non-violence and cowardice, are therefore contrary to each other. Cowardice can never be compatible with non-violence. According to Gandhi non-violence is the greatest virtue and Cowardice or fear is the greatest vice. While non-vilence springs from love, Cowardice originates from hatred.

Gandhi puts emphasis on the concept of non-violence saying that non-violence cannot be used as a separable garment but should be realised as an inseparable and indisepensible part of our very being. Gandhi also gives due importance to the concept of truth and social service. According to him, the basic principle of life is based on truth. He says, "instead of saying God is truth I have been saying truth is God." Gandhi also connects the existence of God to the law that Governs the social well-being of the human being. He says, "I don't regard God as a Person." God is law himself. Therefore, it is impossible to conceive God as breaking the law. Gandhi considers God as an impersonal omniperesent power that pervades the universe and that is imminent in the human soul. He is truth, love and bliss. Devine law is all pervasive.

God realization is the highest good and can be attained through the service of man which means service of all mankind. Love and Ahmisa are two basic instruments through which service of all mankind always finds a positive shape. As Vivekananda says, "he alone lives who lives for

others, rest of others are more dead than alive." It not only the lvoe for human being but also by loving the whole animal world. Ahimsa can become the very basis for the search of Truth or God.

Ahimsa requires not only truthfulness but also fearlessness. The doctrine of fearlessness is an absolute necessity in pursuit of Truth for the final realization of God. Gandhi says, "Ahimsa is the means and Truth is the ends." It is practically impossible to disentangle and separate them". Truth and non-violence, therefore are inseparable and presuppose each other.

In order to make practice of Ahimsa Gandhi lays down five principles:

1. It is possible for all human beings to accept non-violence as a complete self-purification.
2. A non-violent persons by not inflicting violence to any body in the society will attain a community welfare in the long run.
3. The power of a non-violent person is always greater than a violent person.
4. The violence always ends in defeat where as there is no such defeat in non-violence.
5. A person adopting non-violence is always more acceptable and lovable in the society that his counterpart.

According to Gandhi in its positive form Ahimsa means the largest love, greatest charity. Ahimsa implies absence of hatred. If I am a follower of Ahimsa I must love my enemy. Active Ahimsa not only truth and fearlessness but also it calls forth the greatest courage. He says non-violence is the weapon of the strongest and bravest. Non-violence restrains from one's desire for vengeance. Vengeance is weakness, where as forgiveness is one's inner strength. Thus, non-violence implies truthfulness, selfishness harmless, freedom from anger, pride and hatred, live for all men and animals, with fearlessness and courage.

Non-violence is not only a moral weapon of an individual but also a moral weapon of the masses. This moral weapon can be used against all kinds of evil, social, economic or religious. Gandhi says, "Non-violence is a revolution, it is not an armed revolution but a bloodless revolution which can be characterised as revolution of thought and spirit."

After the deliberation on the Gandhian doctrine of non-violence, it can be concluded that the moral autonomy and the moral dignity of a man is complementary to the well-being of a society, the man lives in. The moral truth and social justice that surely makes a basic structure of a healthy society owes its origin very significantly to this Gandhian concept of non-violence.

10.3 SATYAGRAHA:

The word "Satyagraha" etymologically means the firmness in truth. We know, according to Gandhi, truth is always established by truth and can never be by untruth. The love for truth is never possible by the use of violence in any form. Satyagraha, therefore, stands for absolute non-violence. Satyagrah is a moral weapon stressing on soul force and aiming at winning the enemy through love and patient suffering. Though it was used by Gandhi as a struggle for political rights, satyagraha was understood by him as a struggle for individual salvation which could be achieved through love and self-sacrifice.

Gandhian concept of "Satyagraha" is not just theoretical but can be widely taken as a method of universal application starting from domestic and ending in Socio-political field. The instance of a strong political war against the Britishers by adopting non-violence in general and satyagraha in particular as a means in an unsurpassbale record ever occured in the whole World.

Satyagraha in the political field can very oftern be confused as a passive resistance. But Gandhi had made it claear that such passive resistance in this country is not a weapon of the weak but a weaponof the strong. According to Gandhi, Satyagraha is a method of strong having two consequences i.e., it makes a Satyagrahi stonger day by day and to love his opponent which finally brings him to his fold. In other words, Satyagrahi in its form of passive resistance is not merely political policy but is a method of life which makes an individual an active force to bring social, religious and political changes in the Society. A satyagrahi must be prepared for self-suffering in order to punish the opponent. Satyagraha is a movement intended to fight social evils by promoting ethical values. This being a novel fight against the opponent without the slightest physical retaliation Gandhi holds that this method if practised sincerely and rigourously can defeat the opponent in long run.

Gandhi in his scheme of thought uses the concept of non-violence and civil-disobedience against the British rules and become very successful in attaining its result. When Gandhi used civil disobedience and non-cooperation as two branches of Satyagraha, he insisteed that these two methods are to be used to resist evil in a non-violent way. Gandhi by using the concept of Satyagrah as the theory and practice become more successful in the field of achieveing the political end without violent war against the opponents.

Gandhi in his foundation fo Satyagraha has advocated the same ethical principle: "means justifies the ends but not vice-versa." He says, "it is absolutely wrong to suppose that if the motive is pure, the means even if unfair are justified. To realise pure end and means must be pure too". He believes that bad means cannot justifies a good end. Goodness of an action does not merely depend on the motive of the agent or the necessity of the end, but also the ways adopted are more important.

The social welfare of the community being an end could only be achieved by using means that has to be necessarily moral in Gandhian thought. He, therefore cannot support that one is permitted to use immoral or violent means to achieve the moral end. Satyagraha, therefore was invented by Gandhi as a means to achieve socio-political change without the use of violence in any form.

Gandhi while advocating the idea of Satyagraha does not strongly support the idea of mass Satyagraha as long as all people participating in it are not firm in their convictions. he believes that a person is not fit for Satyagraha if he is not willing to practise Satyagraha with all commitments and convictions. As he put, "When I look for the Ahimsa, truth says find it out through me. When I look for the truth, Ahimsa says find it out through me." Thus truth and ahimsa are compatible and complementary to each other.

SUMMARY

Mahatma Gandhi is not an academic Philosopher. But his critical thought to the practical problems of life and society has made him a great philosopher. He has brought a necessary connection between theory and practice. His interpretation of the concepts like Truth, Ahimsa, Satyagraha and Sarvodaya etc. is really novel. For him Truth is the end and ahimsa is the means to attend the end. He says that the Truth is the altimate reality which can only be attended by ahimsa.

The ordinary meaning of ahimsa is non-killing. For him ahimsa does not mean only non-killing but also means non-injury. Even thinking ill of others is ahimsa. So refrening one self from himsa is ahimsa. Gandhi has given a new meaning to ahimsa in its positive aspects. In positive aspect ahimsa means love, compassion, sacrifice etc. Love demands self-sacrifice. If it love which can change one's enmey to his friend. With this ahimsa i.e. the weapon of love Gandhi could make India free from the mighty British Rule.

Satyagraha literary means Satya prati agraha i.e. Steadfastness for Truth. It is the technique of ahimsa with the help of which one can fight and resist all forms of evils in actual life. Gandhi at times has translated Satyagraha as 'Love force', 'Soul force' and 'Truth force'. For Gandhi Truth can never be established by untruth and ahimsa can only be capable of establishing Truth, since it is the expression of true love in thought, speech and action. Thus Satyagraha is the firmness in Truth through the practice of ahimsa.

MODEL QUESTIONS

1. Fill in the blanks.

a) Ahimsa was an ethical principle in ancient India philosophy by Jainism and _____.

b) Non-violence in Gandhian view has two senses: one is positive and the other is _____.

c) In _____ sense love and compassion are considered non-violence according to Gandhi.

d) Non-violence is the greatest virtue but cowardice is a _____.

e) Service of God is service of _____.

f) Ahimsa requires fearlessness and _____.

g) Ahima is the means and _____ in the end.

h) Non-violence is not only a moral weapon of individual but also of _____.

2. a) What is the meaning of the word 'ahimsa'?

b) What are the two senses of the word ahimsa, according to Gandhi.

c) Why a coward is not called non-violent according to Gandhi ?

3. Answer briefly.

a) Write any two principles for practising non-violence.

b) What is non-violence in the positive sense ?

c) How Gandhi equates love with non-violence ?

4. Essay type question:

a) Discuss Gandhian view of non-violence.

b) Distinguish between non-injury and non-violence according to Gandhian.

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