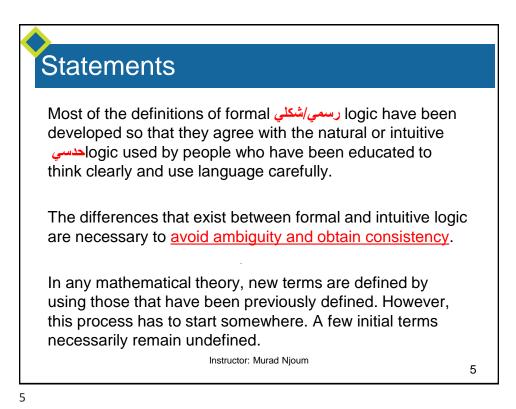
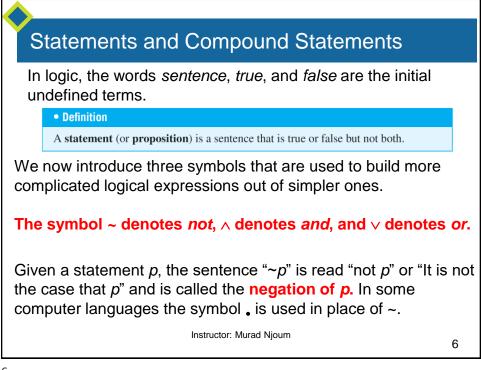


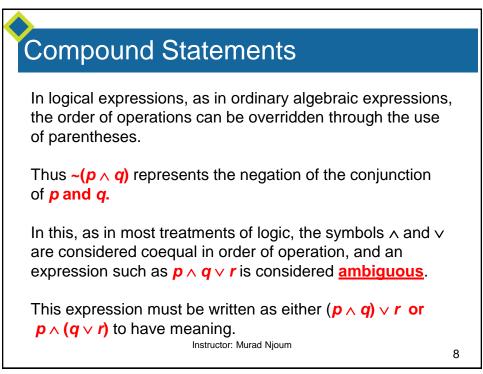
Example 1 – Identifying Logical Form	т
Fill in the blanks below so that argument (b) has the same as argument (a). Then represent the common form of the arguments using letters to stand for component sentences	
<ul> <li>a. If Ahmad is a <u>math</u> major or <u>Ahmad</u> is a <u>computer science</u> major, then Ahmad will take <u>Math 331</u>. Ahmad is a conscience major. Ahmad will take Math 331.</li> </ul>	
<b>b.</b> If logic is easy or $(1)$ , then $(2)$ .	
I will study hard. I will get an A in this course.	
Instructor: Murad Njoum	3

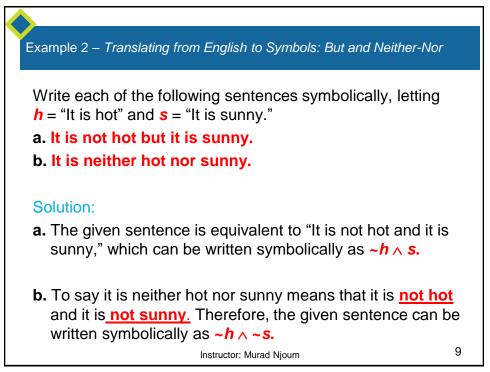
Example 1 – Solution	
1. I (will) study hard.	
2. I will get an A in this course.	
Common form: If p or q, then r. q. Therefore, r.	
Instructor: Murad Njoum	4



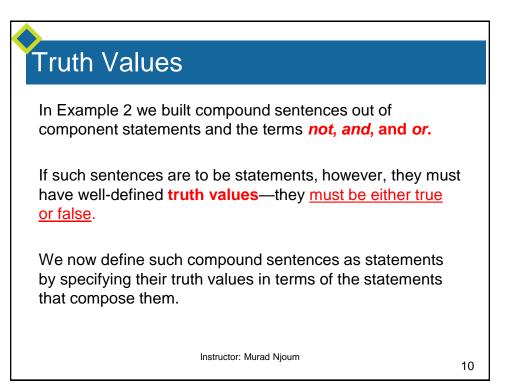


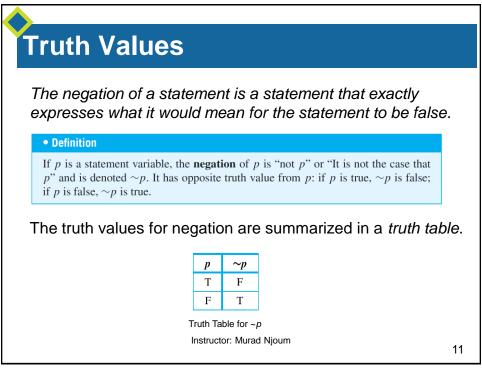
Compound Statements		
	Given another statement $q$ , the sentence " $p \land q$ " is read " $p$ and $q$ " and is called the conjunction of $p$ and $q$ .	
	The sentence " $p \lor q$ " is read " <i>p</i> or <i>q</i> " and is called the <b>disjunction of</b> <i>p</i> and <i>q</i> .	
	In expressions that include the symbol $\sim$ as well as $\land$ or $\lor$ , the <b>order of operations</b> specifies that $\sim$ is performed first.	
	For instance, $\sim p \land q = (\sim p) \land q$ .	
	Instructor: Murad Njoum	7

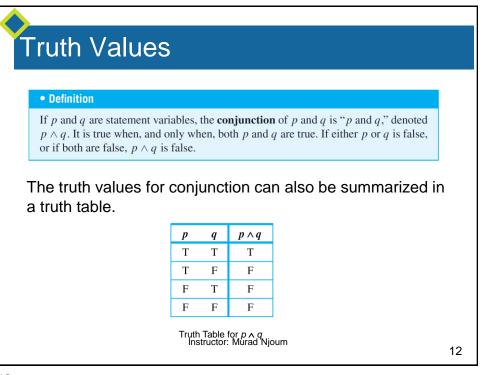


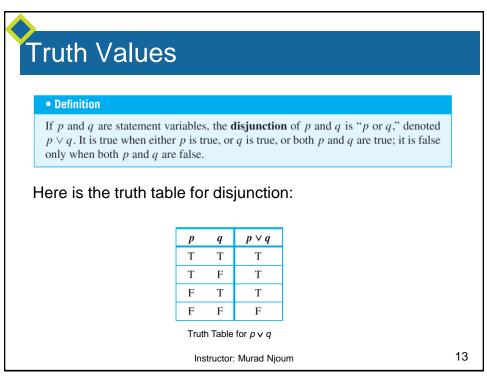


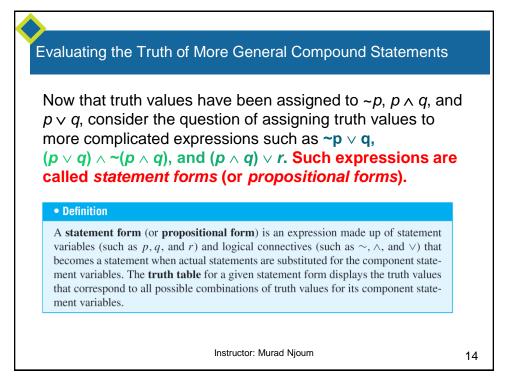


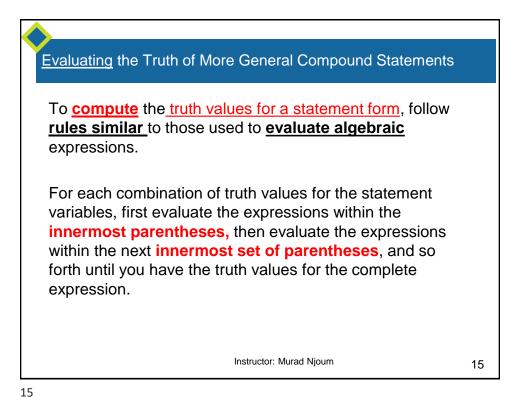


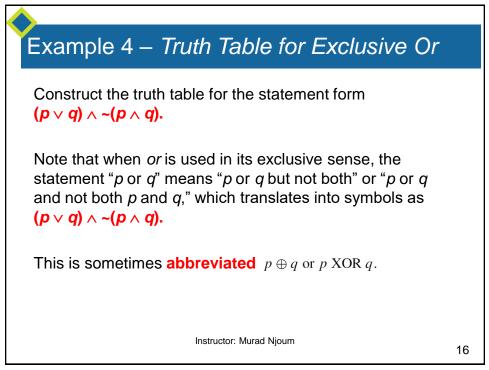


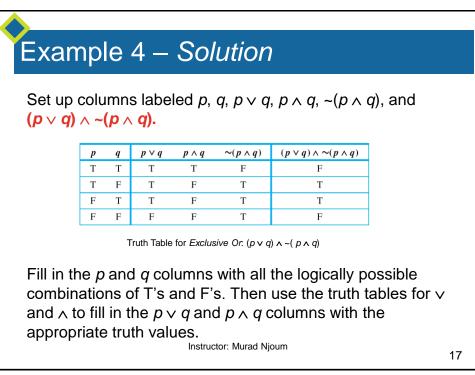


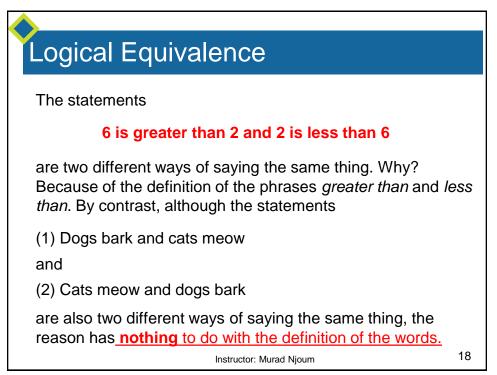


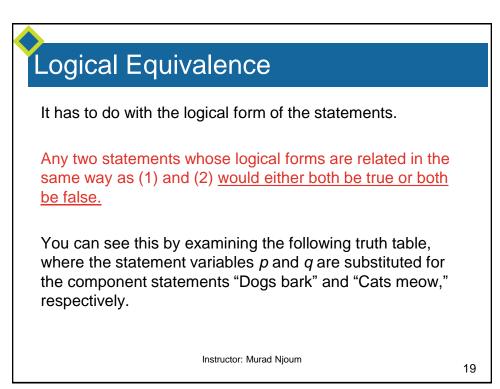


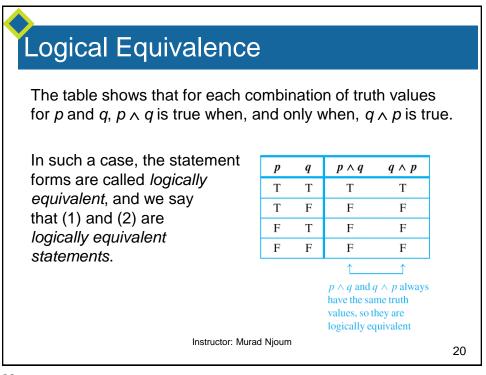














#### • Definition

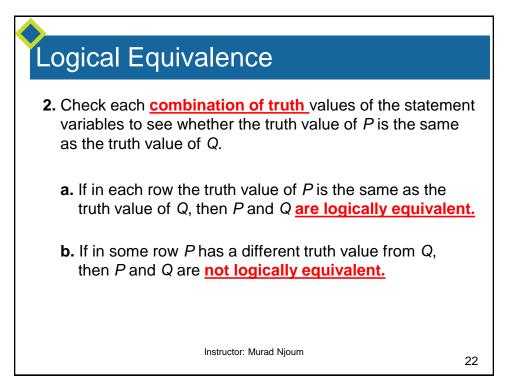
Two *statement forms* are called **logically equivalent** if, and only if, they have identical truth values for each possible substitution of statements for their statement variables. The logical equivalence of statement forms P and Q is denoted by writing  $P \equiv Q$ . Two *statements* are called **logically equivalent** if, and only if, they have logically equivalent forms when identical component statement variables are used to replace identical component statements.

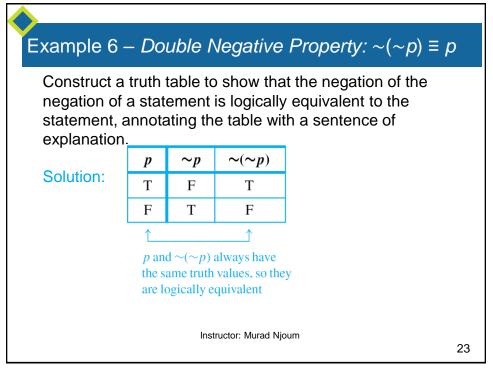
## Testing Whether Two Statement Forms *P* and *Q* Are Logically Equivalent

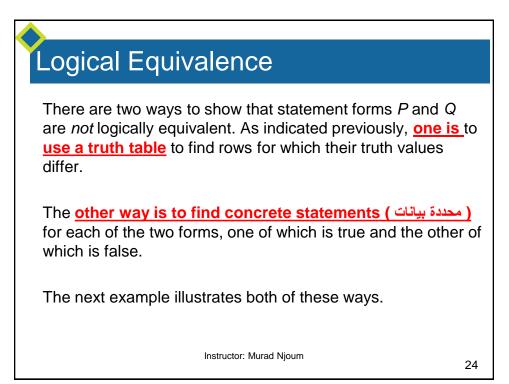
1. <u>Construct a truth table</u> with one column for the truth values of *P* and another column for the truth values of *Q*.

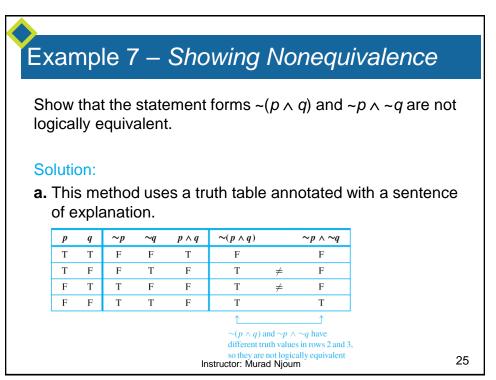
Instructor: Murad Njoum

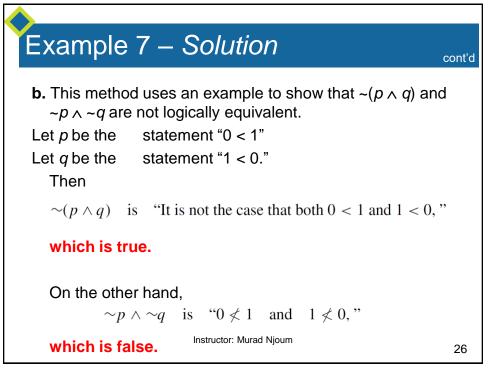
21



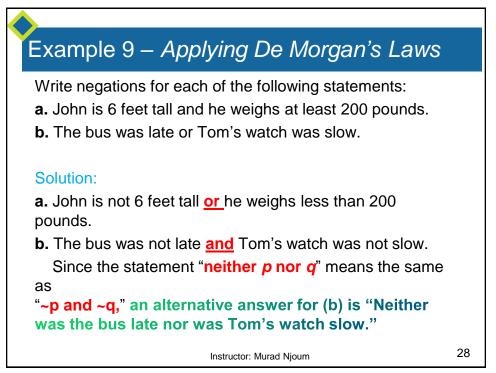








Logical Equivalence			
The two logical equivalences are known as <b>De Morgan's</b> <b>laws</b> of logic in honor of Augustus De Morgan, who was the first to state them in formal mathematical terms.			
De Morgan's Laws			
The negation of an <i>and</i> statement is logically equivalent to the <i>or</i> statement in which each component is negated.			
The negation of an <i>or</i> statement is logically equivalent to the <i>and</i> statement in which each component is negated.			
Symbolically we can represent the two logic equivalences			
<b>as:</b> $\sim (p \land q) \equiv \sim p \lor \sim q$			
and $\sim (p \lor q) \equiv \sim p \land \sim q.$			
Instructor: Murad Njoum	27		



## Tautologies and Contradictions

#### Definition

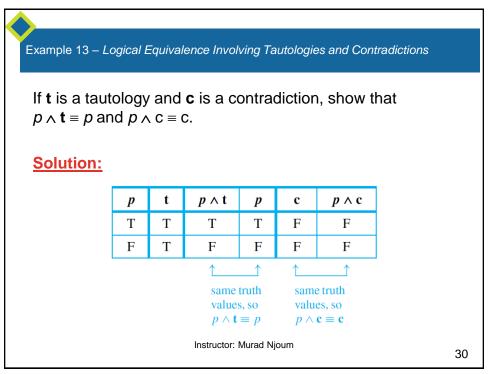
A **tautology** is a statement form that is <u>always true regardless of the truth</u> values of the individual statements substituted for its statement variables. A statement whose form is a tautology is a **tautological statement**.

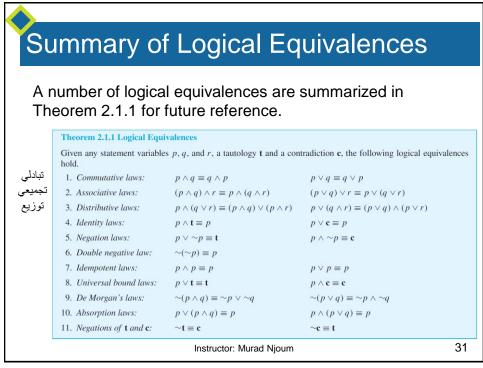
A **contradication** is <u>a statement form that is always false</u> regardless of the truth values of the individual statements substituted for its statement variables. A statement whose form is a contradication is a **contradictory statement**.

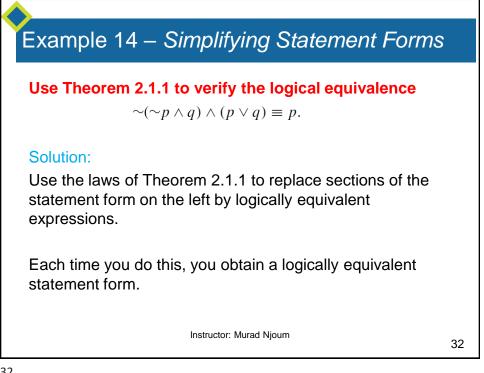
According to this definition, the truth of a tautological statement and the falsity of a contradictory statement are due to the logical structure of the statements themselves and are independent of the meanings of the statements.

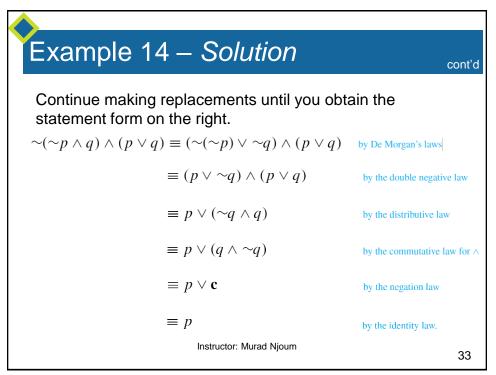
Instructor: Murad Njoum

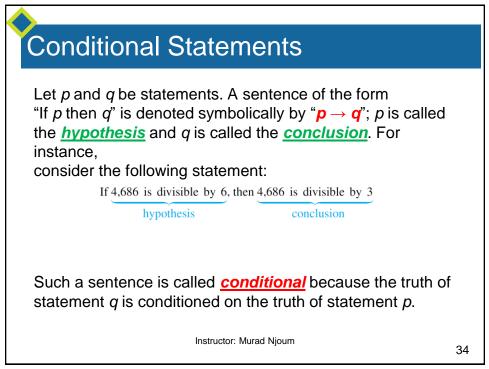
29

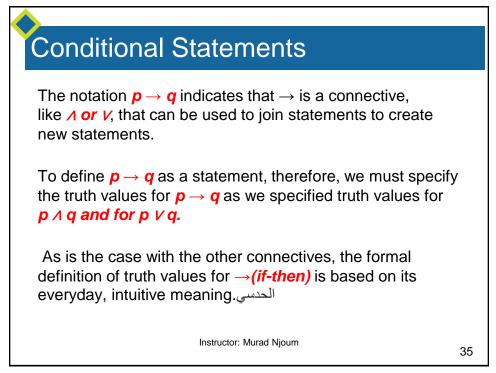


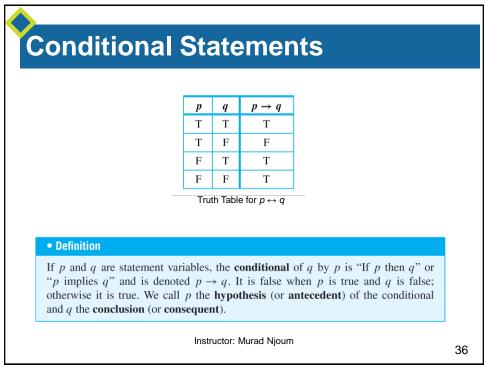


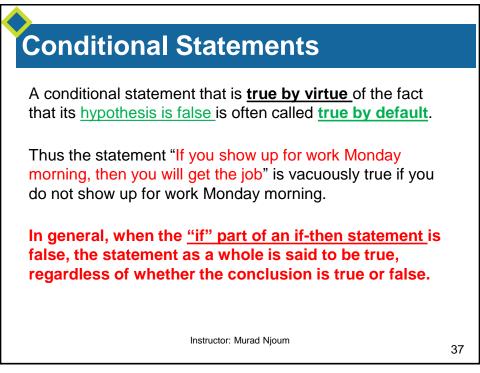


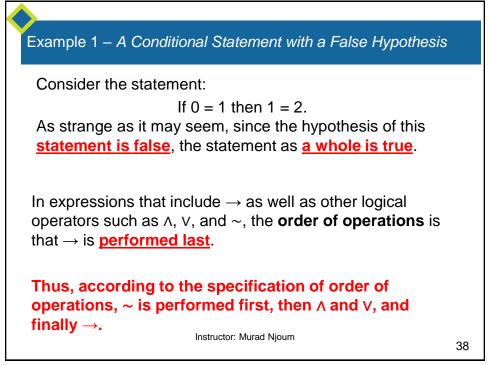


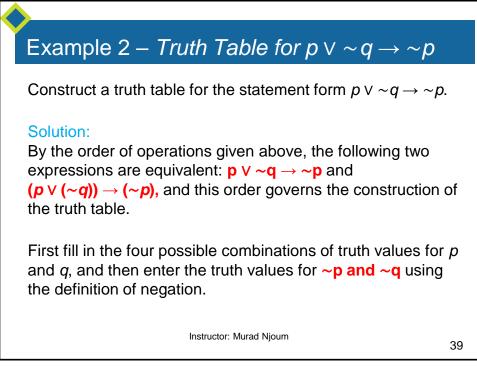


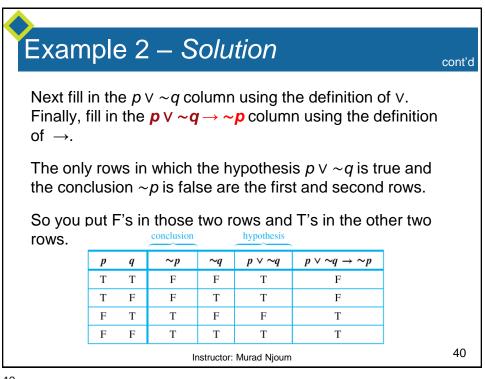


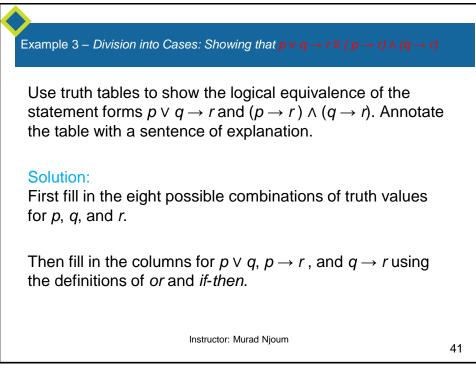


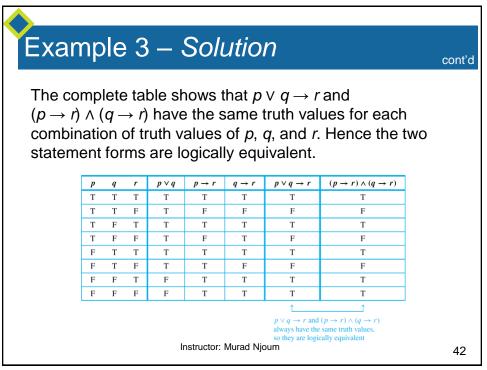










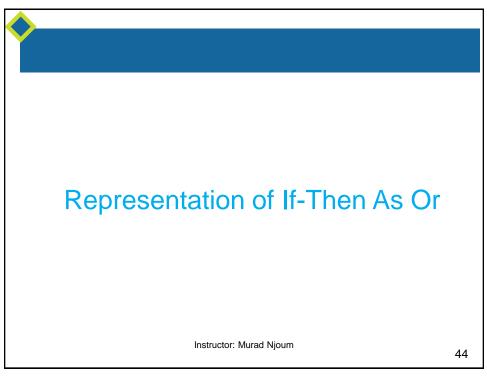


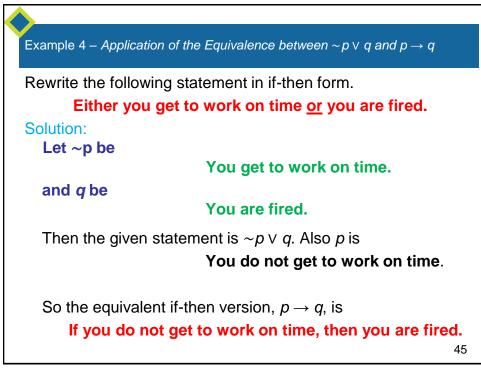
# Important example

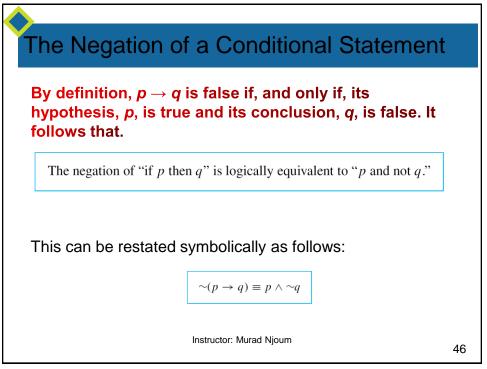
Given:		p: 7 <sup>2</sup> = 49.	true
		q: A rectangle does not have 4 sides.	false
		r: Harrison Ford is an American actor.	true
		s: A square is not a quadrilateral.	false
Pro	blem:	Write each conditional below as a sentence. Then indicate its truth value.	
1.	p→q	If 7 <sup>2</sup> is equal to 49, then a rectangle does not have 4 sides.	false
2.	q→r	If a rectangle does not have 4 sides, then Harrison Ford is an American actor.	true
3.	p→r	If $7^2$ is equal to 49, then Harrison Ford is an American actor.	true
4.	q→s	If a rectangle does not have 4 sides, then a square is not a quadrilateral.	true
5.	r→~p	If Harrison Ford is an American actor, then $7^2$ is not equal to 49.	false
6.	∼r→p	If Harrison Ford is not an American actor, then 7 <sup>2</sup> is equal to 49.	true

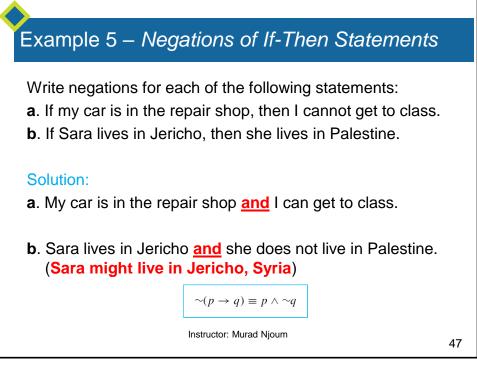
Instructor: Murad Njoum

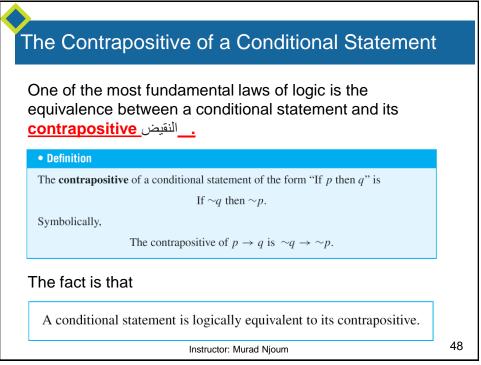
43

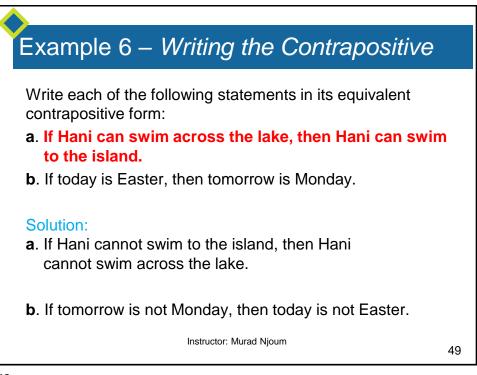


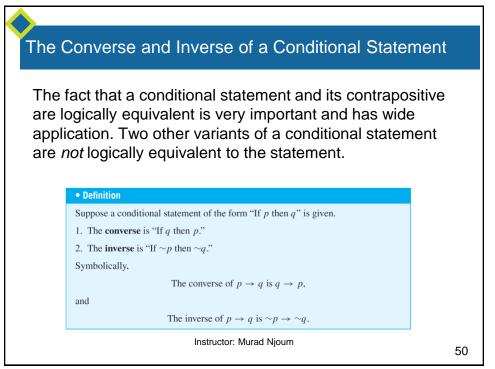


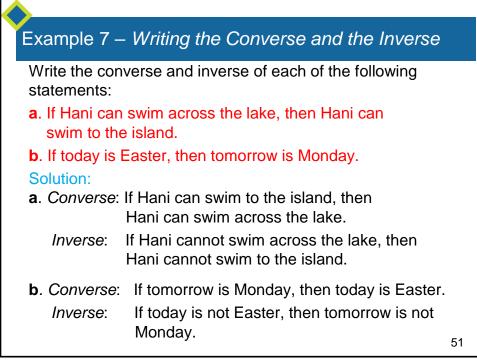


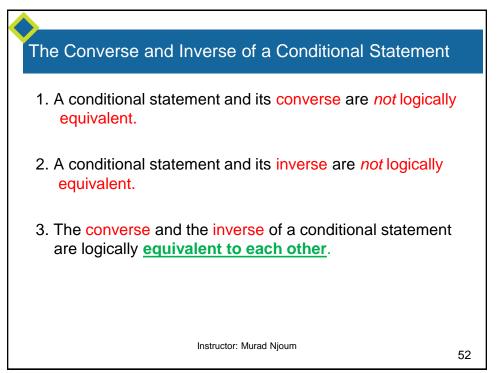




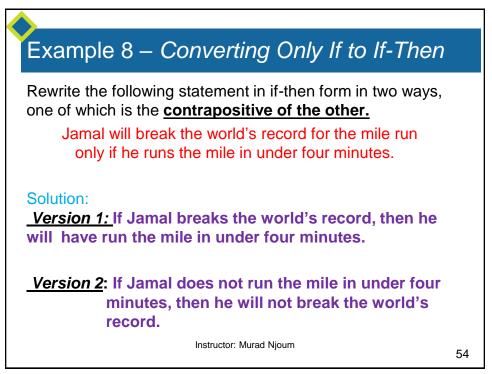


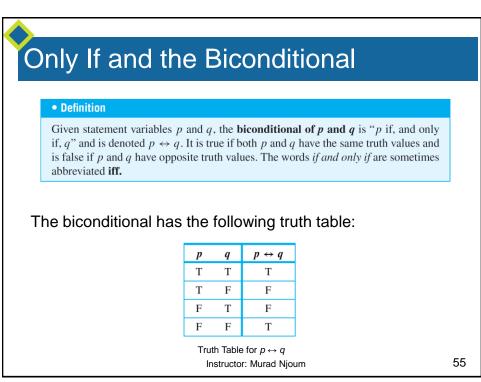


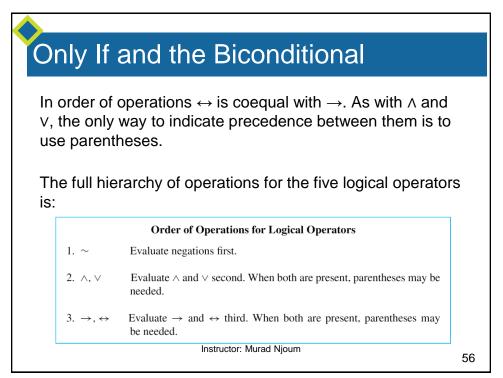


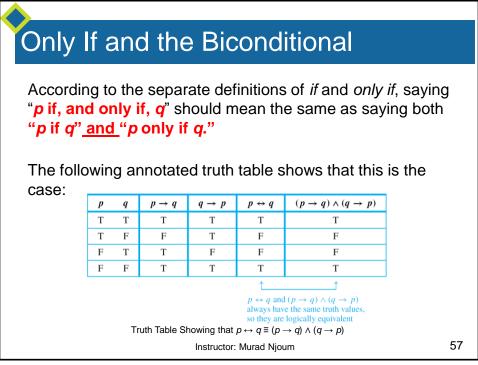


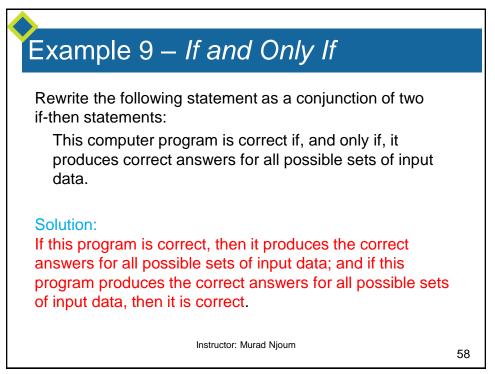
¢	Only If and the <u>Biconditional</u>		
To say " <i>p</i> only if <i>q</i> " means that <i>p</i> can take place only if <i>q</i> takes place also. That is, if <i>q</i> does not take place, then <i>p</i> cannot take place. Another way to say this is that if <i>p</i> occurs, then <i>q</i> must also occur (by the logical equivalence between a statement and <u>its contrapositive</u> ).			
	Definition		
	It $p$ and $q$ are statements,		
	p only if $q$ means "if not $q$ then not $p$ ,"		
	or, equivalently,		
	"if $p$ then $q$ ."		
	Instructor: Murad Njoum	53	



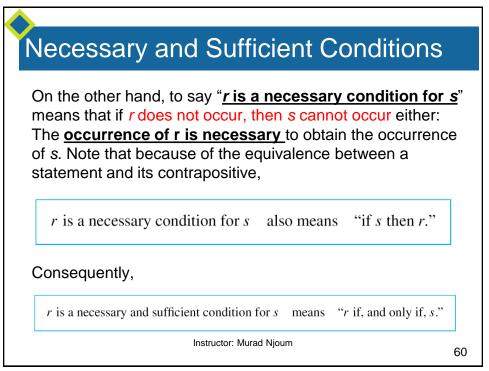


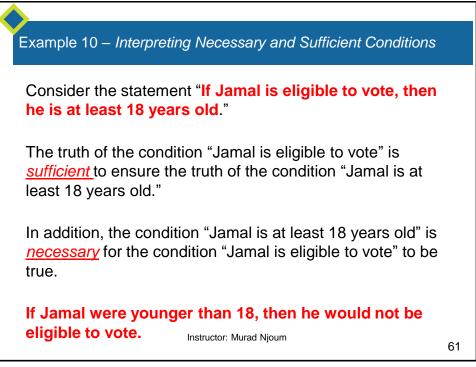


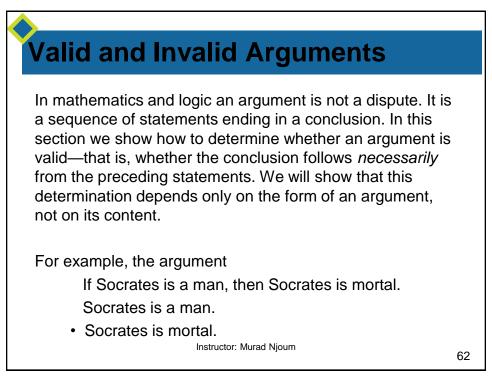




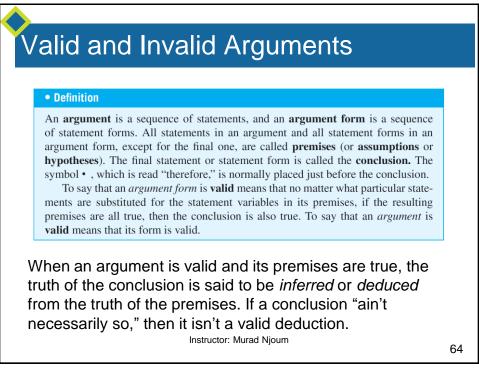
N	Necessary and Sufficient Condition			
The phrases <i>necessary condition</i> and <i>sufficient condition</i> , as used in formal English, correspond exactly to their definitions in logic.				
Definition				
	If $r$ and $s$ are statements:			
	<i>r</i> is a <b>sufficient condition</b> for <i>s</i> means "if <i>r</i> then <i>s</i> ." <i>r</i> is a <b>necessary condition</b> for <i>s</i> means "if not <i>r</i> then not <i>s</i> ."			
In other words, to say " <i>r</i> is a sufficient condition for <i>s</i> " means that the occurrence of <i>r</i> is <u>sufficient</u> to guarantee the occurrence of <i>s</i> .				
	Instructor: Murad Njoum	59		

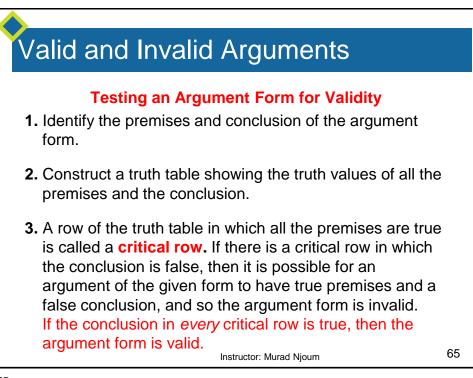






Valid and Invalid Arguments		
has the abstract form		
If <i>p</i> then <i>q</i>		
ρ		
• q		
When considering the abstract form of an argument, think of $p$ and $q$ as variables for which statements may be substituted.		
An argument form is called <i>valid</i> if, and only if, whenever statements are substituted that make all the premises true, the conclusion is also true.		
Instructor: Murad Njoum 6	3	



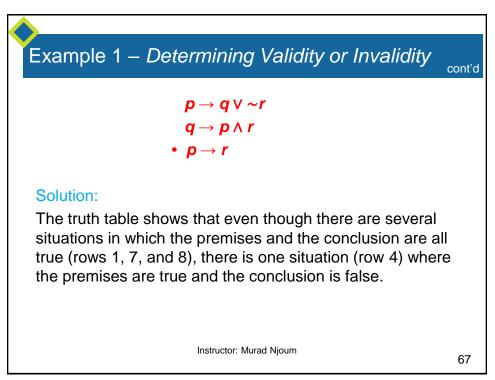


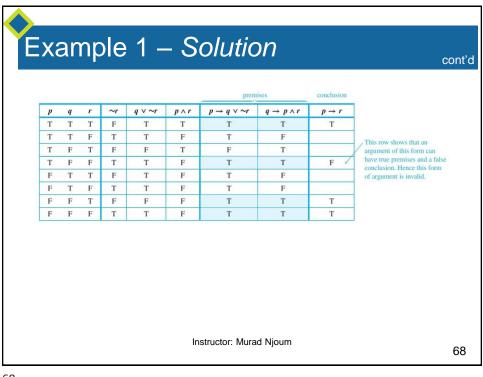
### Example 1 – Determining Validity or Invalidity

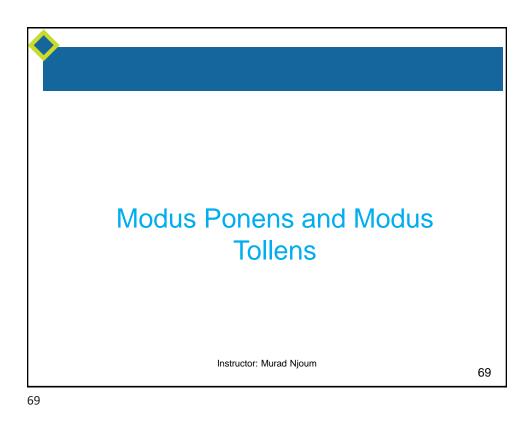
Determine whether the following argument form is valid or invalid by drawing a truth table, indicating which columns represent the premises and which represent the conclusion, and annotating the table with a sentence of explanation.

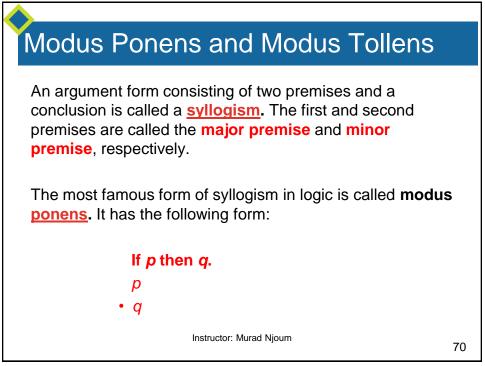
When you fill in the table, you only need to indicate the truth values for the conclusion in the rows where all the premises are true (the critical rows) because the truth values of the conclusion in the other rows are irrelevant to the validity or invalidity of the argument.

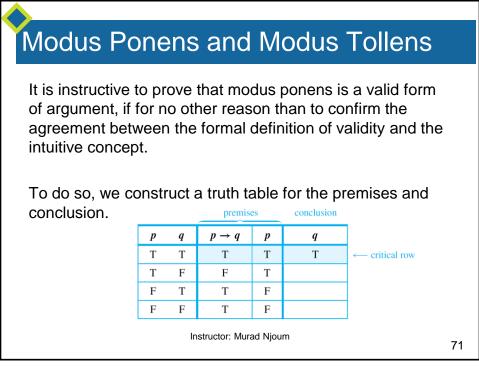
Instructor: Murad Njoum

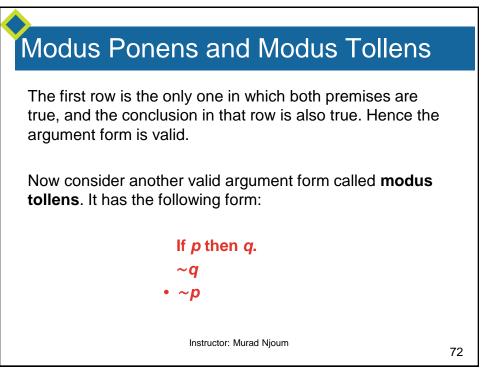


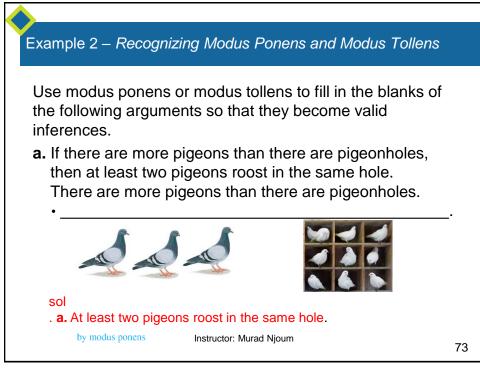


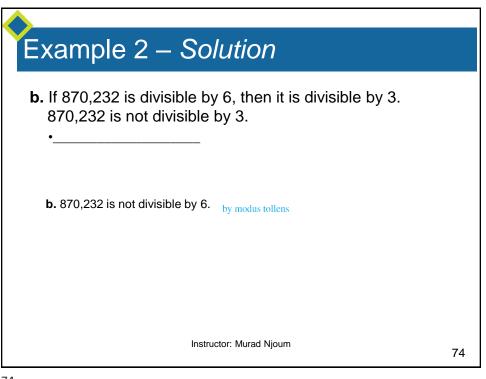


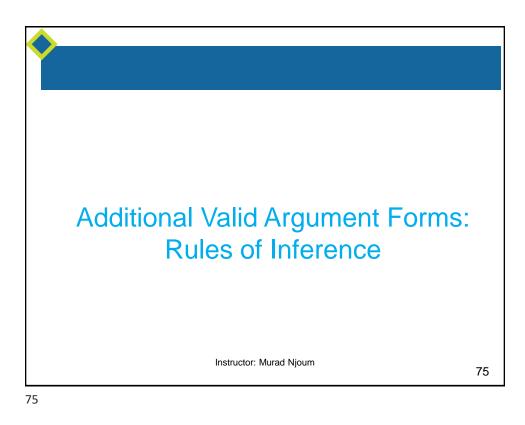


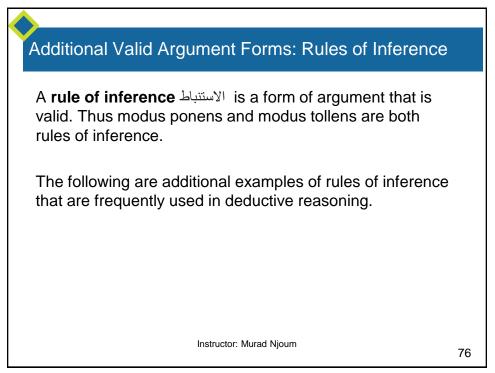


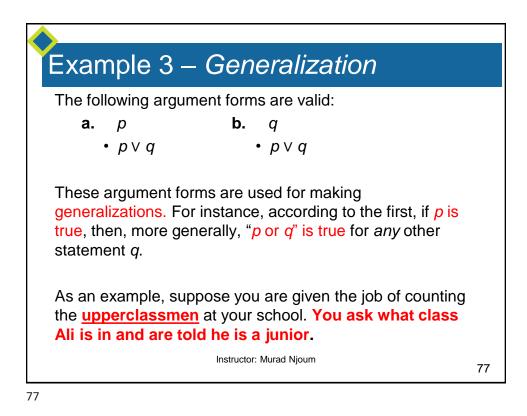


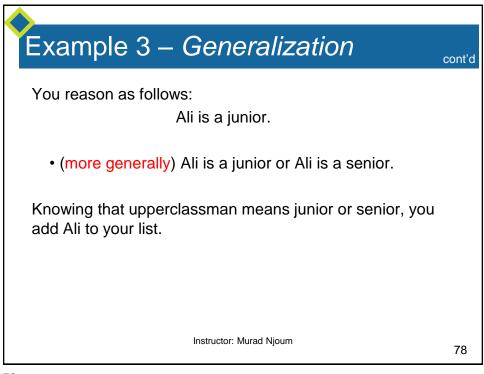


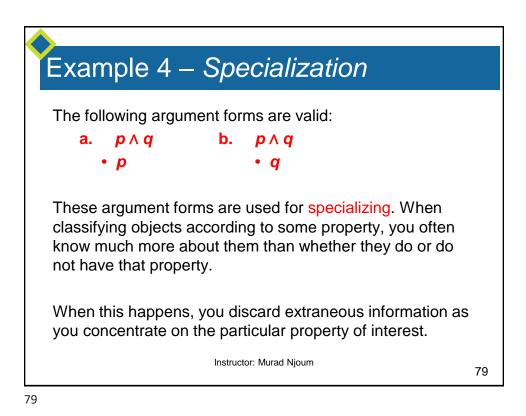


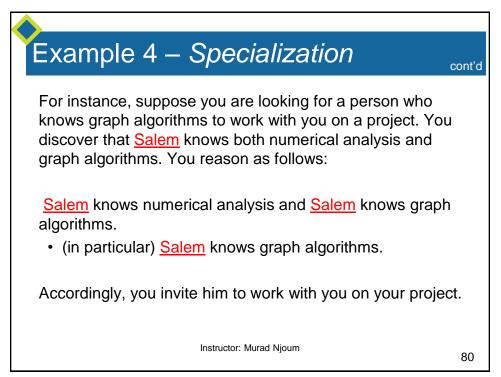


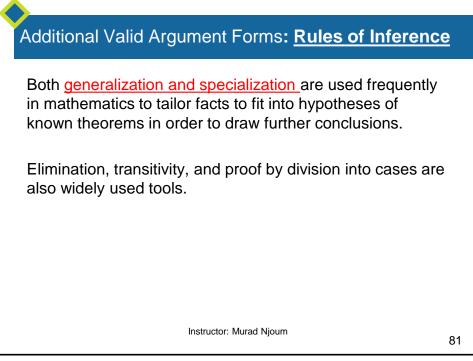


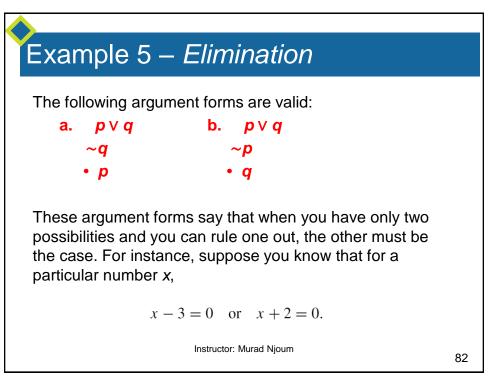


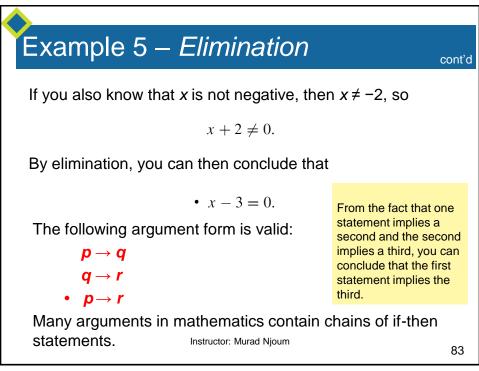


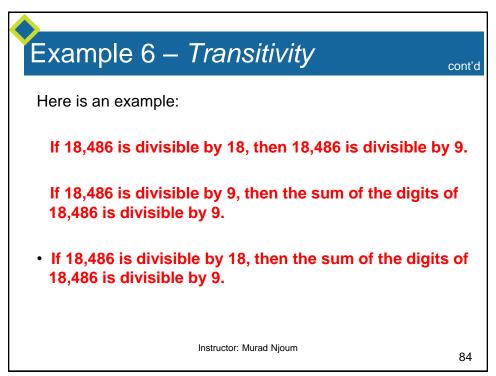


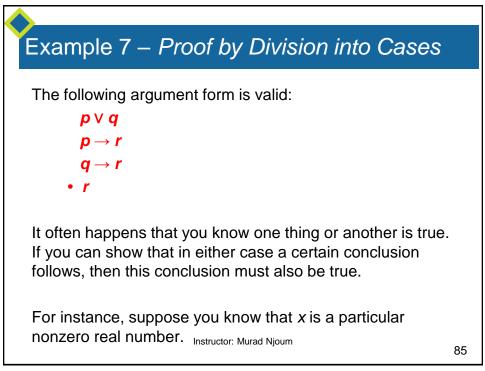


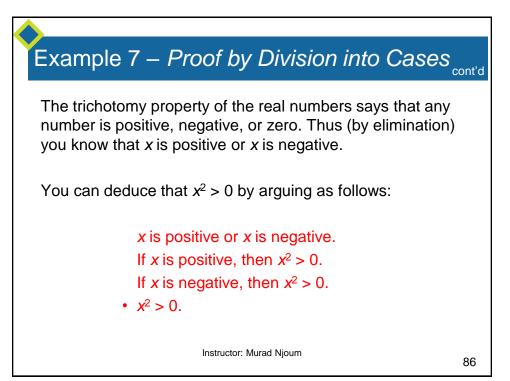


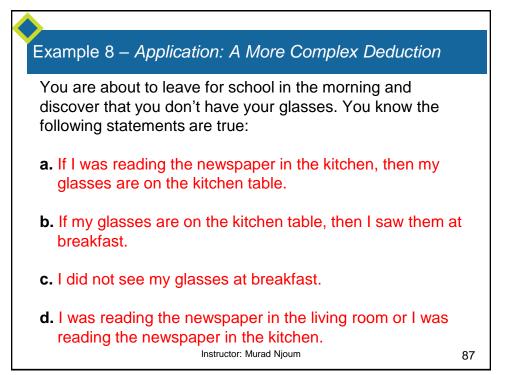


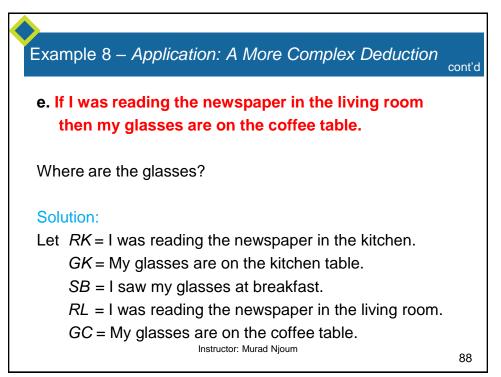


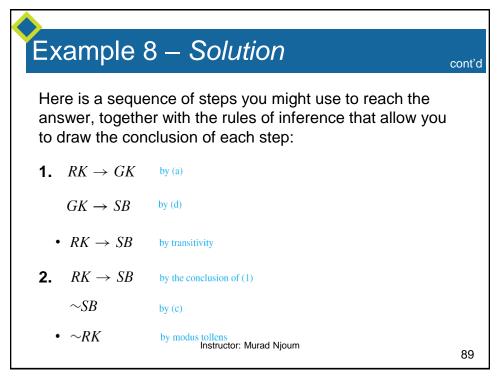


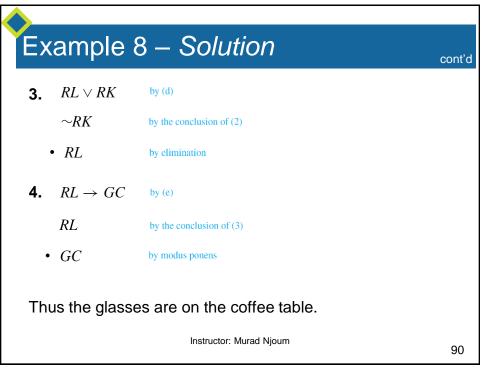














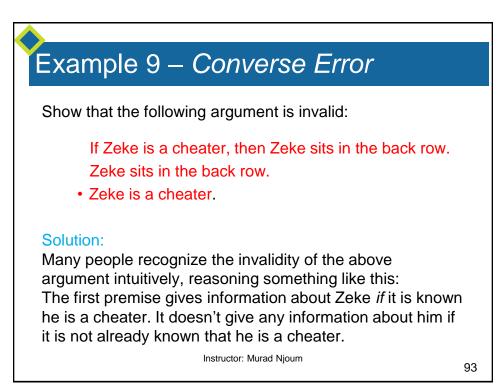
## (مغالطة) Fallacies

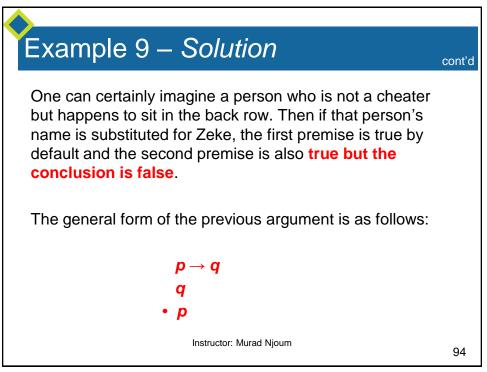
A **fallacy** is an error in reasoning that results in an invalid argument. Three common fallacies are **using ambiguous premises**, and treating them as if they were unambiguous, **circular reasoning** (assuming what is to be proved without having derived it from the premises), and **jumping to a conclusion** (without adequate grounds).

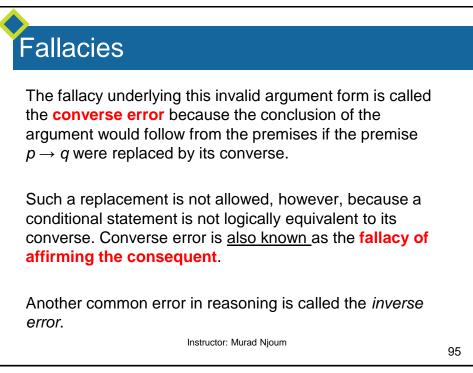
In this section we discuss two other fallacies, called *converse error* and *inverse error*, which give rise to arguments that superficially resemble those that are valid by modus ponens and modus tollens but are not, in fact, valid.

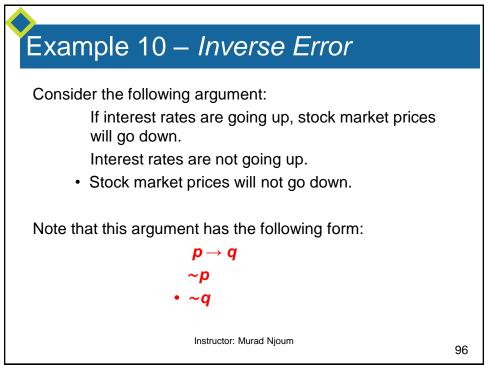
For an argument to be valid, every argument of the same form whose premises are all true must have a true conclusion. It follows that for an argument to be invalid means that there is an argument of that form whose premises are all true and whose conclusion is false.

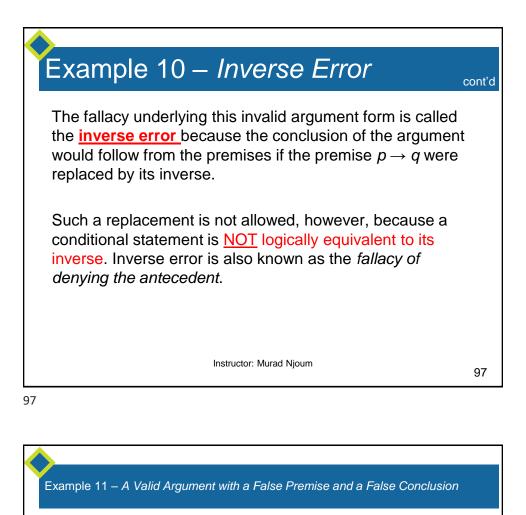
Instructor: Murad Njoum











The argument below is valid by modus ponens. But its major premise is false, and so is its conclusion.

If Mohmmad Ali Klay was a Boxing star, then Mohmmad Ali Klay had black hair. Mohmmad Ali Klay was a rock star.

• Mohmmad Ali Klay had black hair.

Instructor: Murad Njoum

