

Symbolic Logic on the TI-92

Presented by
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Abstract

Symbolic Logic is taught from ninth grade through graduate school. The TI-92 has built-in operations which can be used in the study of symbolic logic. The machine is capable of finding truth values, building truth tables and “proving” simple statements. This paper discusses and illustrates how to do the basic problems encountered in beginning work in symbolic logic; use it as a reference for

- Built in operators
- Truth tables
- Defining other logical operators
- “Proofs”
- Teaching Suggestions

Built-in Operators

Statements in logic are sentences which can be assigned a truth value (**true** or **false**). In the study of logic, and on the TI-92, a statement is represented by a variable. To assign a truth value to a variable store the truth value to the variable by using the store key [STO>]. To save typing it is helpful to assign **t** the value **true** and **f** the **false** when working with logic. These in turn may be used to assign a list of truth values to other variables, say **p** and **q**, which will later be used later to build truth tables. (See Figure 1)

The image shows a TI-92 calculator screen with a menu at the top: F1 Algebra, F2 Calc, F3 Other, F4 PrgmIO, F5 Clear a-z... Below the menu, several logic operations are listed with their results:

■ true → t	true
■ false → f	false
■ (t t f f) → p	(true true false false)
■ (t f t f) → q	(true false true false)
■ p and ~q	(false true false false)
■ ~(t or f)	false

At the bottom of the screen, the text **not(t or f)** is displayed in a larger font. The status bar at the very bottom shows "MAIN", "RAD AUTO", and "FUNC 6/30".

Figure 1: Assigning truth values to **t** and **f**; storing lists of truth values and simple logic statements.

The logical (Boolean) operators **and**, **or**, **not** and **xor** (but *not* “if..., then ...” or “...if, and only if...”) are built into the TI-92. They are available on the home screen and in the table editor by typing them between (or before) logical variables just as they would be written on paper. (See Figure 1 — entry line).

Truth Tables

The TI-92 returns a list of lists as a matrix. One way to produce a truth table is to enter the desired lines as a list. The truth table will be returned as a matrix with the *rows* corresponding to entries in the original list. (See figure 2)

F1	F2	F3	F4	F5	F6																
←	Algebra	Calc	Other	PrgmIO	Clear a-z...																
<p>▪ {p q p and q q or ^p}</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>true</td><td>true</td><td>false</td><td>false</td></tr> <tr><td>true</td><td>false</td><td>true</td><td>false</td></tr> <tr><td>true</td><td>false</td><td>false</td><td>false</td></tr> <tr><td>true</td><td>false</td><td>true</td><td>true</td></tr> </table>						true	true	false	false	true	false	true	false	true	false	false	false	true	false	true	true
true	true	false	false																		
true	false	true	false																		
true	false	false	false																		
true	false	true	true																		
<p>{p, q, p and q, q or not p}</p>																					
MAIN	RAD AUTO	FUNC 1/30																			

Figure 2: The truth table for p and q and q or *not* p . Note that the rows (not the columns) correspond to the four expressions in the list above the matrix and on the entry line at the bottom.

Truth tables are usually arranged with the *columns* corresponding to the various logical statements. This arrangement can be done using the TI-92’s Data/Matrix Editor. Enter p in the header cell (second row) of the first column (c1) and q in the header cell of the second column (c2). The columns will be filled automatically. Then enter the logical statement for each column in its header cell using c1 and c2 (instead of p and q). The proper results are printed in each column by the TI-92. (See Figure 3)

F1	F2	F3	F4	F5	F6	F7
←	Plot Setup	Cell	Header	Calc	Util	Stat
DATA	p	q	p and q	q or ^p		
	c1	c2	c3	c4		
1	true	true	true	true		
2	true	false	false	false		
3	false	true	false	true		
4	false	false	false	true		
5						
6						
7						
<p>c4=c2 or not c1</p>						
MAIN	RAD AUTO	FUNC				

Figure 3: The header cell for c4 is shown on the entry line; notice how the columns c1 and c2 are referenced.

Defining Logical Operators

As Figure 5 below shows, each set of hypotheses is entered on one line connected by **and**. In each case the TI-92 returns *all* of the true statements. If the conclusion is among them, then the theorem can be proved. The first two examples can be proved since the desired conclusion is the “answer” line for each. The third theorem is not true as the “false” indicates; therefore it cannot be proved.

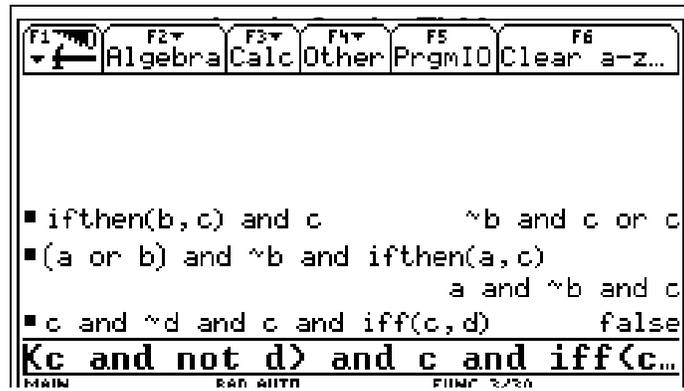


Figure 5: Three simple logic proofs.

Teaching Suggestion

The operation **xor** is not encountered in many texts. It is however available on the TI-92. Consider *not* discussing **xor** with your class. As part of their assessment ask a question like this one:

There is another logical operator which can be used directly on the TI-92. It is called **xor** and is written between two statements like this $p \text{ xor } q$.

- (a) Use the TI-92 to make a truth table for **xor**.
- (b) Study the truth table and determine what **xor** means. Explain its meaning words, and give an example.
- (c) The truth table for **xor** is exactly the opposite (negation) of one of the other logical operator you have studied. Complete the following statement and then show that it is a tautology: $(p \text{ xor } q) \leftrightarrow \sim (\quad ? \quad)$