Truth Tables

I. **Negation (~ : not)** expresses the opposite truth value.

p	$\sim p$
T	F
F	T

II. **Conjunction (∧ : and)** is true only when both statements are true.

p	q	$p \wedge p$
T	T	T
T	F	F
F	T	F
F	F	F

III. Disjunction (∨: or) is false only when both statements are false.

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

IV. Conditional (→ : if-then) is false only when the antecedent (1st) is true and the component (2nd) is false.

p	q	$p \rightarrow q$
T	T	T
T	F	F
F	T	T
F	F	T

V. Biconditional (↔ : if and only if) is true only when the component statements have the same truth value.

p	q	$p \leftrightarrow q$
T	T	T
T	F	F
F	T	F
F	F	T

VI. Order to perform logic operators in truth tables:

- Parenthesis
  - ( )
- Negation
  - ~
- Conjunction
  - ∧
- Disjunction
  - ∨
- Conditional and Biconditional
  - → and ↔

VII. Truth Table Examples:

1. $\sim p \wedge p$

p	$\sim p$	$\sim p \wedge p$
T	F	F
F	T	F

2. $\sim(p \wedge q)$

p	q	$(p \wedge q)$	$\sim (p \wedge q)$
T	T	T	F
T	F	F	T
F	T	F	T
F	F	F	T

3. $p \vee \sim q$

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

4. $\sim(p \vee q)$

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

F	F	T	T

F	F	F	T

5. $(p \wedge q) \vee r$

p	q	r	$(p \wedge q)$	$(p \wedge q) \vee r$
T	T	T	T	T
T	T	F	T	T
T	F	T	F	T
T	F	F	F	F
F	T	T	F	T
F	T	F	F	F
F	F	T	F	T
F	F	F	F	F

6. $p \rightarrow (q \wedge r)$

p	q	r	$(q \wedge r)$	$p \rightarrow (q \wedge r)$
T	T	T	T	T
T	T	F	F	F
T	F	T	F	F
T	F	F	F	F
F	T	T	T	T
F	T	F	F	T
F	F	T	F	T

F	F	F	F	T

7. Determine the truth value for *~p* ∧ (*~q* ∨ *r)* when *p* is false, *q* is true, and *r* is false.

~p ∧ (~q ∨ r)	Original statement
~F ∧ (~T ∨ F)	Original statement with truth values
~F ∧ (F ∨ F)	Perform the negation in the parenthesis
~F ∧ (F)	Finish the parenthesis
T ∧ (F)	Perform the negation
False	Perform the conjunction

8. Determine the truth value for *~p* ∨ *~(q* ∨ *r)* when *p* is false, *q* is true, and *r* is false.

~p ∨ ~(q ∨ r)	Original statement
~F ∨ ~(T ∨ F)	Original statement with truth values
~F ∨ ~(T)	Perform the parenthesis
T ∨ F	Perform the negations
True	Perform the disjunction

9. Determine the truth value for *(~p* ∧ *q)* ↔ *~r* when *p* is false, *q* is true, and *r* is false.

(~p ∧ q) ↔ ~r	Original statement
(~F ∧ T) ↔ ~F	Original statement with truth values
(T ∧ T) ↔ ~F	Perform the negation in the parenthesis
(T) ↔ ~F	Finish the parenthesis

T ↔ T	Perform the negation
True	Perform the biconditional