CHAPTER 6
STATEMENTS AND SOME OPERATIONS

Statements

A statement will be denoted by a letter
p, *q*, *r*, ...

The fundamental property of a statement: *true*, *false*, but not both.

The truthfulness or falsity of a statement is called its *truth value*. The truthfulness of *p* is denoted by $\tau(p)$.

Example:

1. "What are you going to do?"
   is not a statement (it is neither true nor false)

2. "Please solve all these problems"
   is not a statement (it is neither true nor false, as it is just an instruction)

3. "Bandung is the capital city of West Java and 3+3 = 33"
   is a statement (it is true)

4. "Jakarta is in Java Island"
   is a statement (it is true)

Example:

1. p : 4 + 7 = 47. Then $\tau(p)$=F.

2. q : 2 is a prime number. Then $\tau(q) = T$.

Operations on Logic

Unary Operations: Negation
Binary Operations: Conjunctions, Disjunctions, Implication, Biimplication

Conjunction

Any two statements can be combined by the word "and" to form a composite statement. This operation is called *conjunction.*

Symbolically, the conjuction of the two statement p and q is denoted by $p \wedge q$.

Example:

p : 3 is odd-prime number.
q : 2 is even-prime number.
$p \wedge q$: 3 is odd-prime number and 2 is even-prime number".

p : a square is a polygon.
q : a parallelogram is *a* polygon.
$p \wedge q$: A square and a parallelogram are a polygon.

Truth Tables
A convenient way to state the truthfulness of a compound statement is by means of a truth table as follows:

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

Disjunction

Any two statements can be combined by the word “or” to form a composite statement. This operation is called *disjunction.*

Symbolically, the disjunction of the two statement *p* and *q* is denoted by $p \vee q$.

Example:

1. *p* : Paris is in France.
   q : 2 + 5 = 7.
   $p \vee q$: Paris is in France and 2 + 5 = 7.

2. *p* : 7 is an odd number.
   q : 7 is a *prime number.*
   $p \vee q$: 7 is an odd and prime number.

We can express the truthfulness of a conjunction statement by using the following truth table:

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

Implications, conditional statement

Any statements which is in the form of “If *p* then *q*” is called *conditional statement,* and the operation is called *implication.*

Symbolically, the implication “If *p then* q” is denoted by $p \rightarrow q$.

The conditional statement $p \rightarrow q$ can also be read as
(a) *p* implies *q.*
(b) *p only if q.*
(c) *p* is sufficient for *q.*
(d) *q* is necessary for *p.*

Example:

1. *p* : Paris is in France.

q : 2 + 5 = 7.
p → *q* : If Paris is in France, then 2 + 5 = 7.

2. *p* : 7 is an odd number.
   q : 7 is a *prime number.*
   p → *q* : If 7 is an odd number, then 7 is a prime number.

We can denote an implication operation (for conditional statement) by using apllying the truth table as follows:

p	*q*	*p* → *q*
T	T	T
T	F	F
F	T	T
F	F	T

Biimplications, **biconditional statement**

Any statements which is in the form of
"*p* if and only if *q*"
is called *biconditional statement,* and the operation is called *biimplication.*

Symbolically, the implication "*p if and olnly if q*" is denoted by $p \Leftrightarrow q$.

Example:

1. *p* : Surabaya is in East Java.
   q : 111 + 11 = 11111.
   $p \Leftrightarrow q$: Surabaya is in East Java if and only if 111 + 11 = 11111.

2. *p* : 8 is a composite number.
   q : 8 is not a *prime number.*
   $p \Leftrightarrow q$: 8 is a composite number if and only if 8 is not a prime number.

Biimplication operations (for constructing biconditional statements) can be represented by a truth table.
The following table describe the truthfulness of the statement $p \Leftrightarrow q$:

p	*q*	$p \Leftrightarrow q$
T	T	F
T	F	T
F	T	T
F	F	F

The following is an abbreviated truth table:

$(p \rightarrow (q \wedge r)) \wedge (\neg p \rightarrow (\neg q \wedge \neg r)$

T	T	T
T	T	F
T	F	T
T	F	F

F	T	T
F	T	F
F	F	T
F	F	F