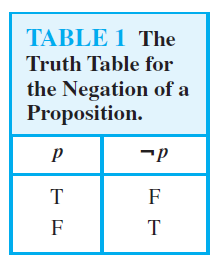
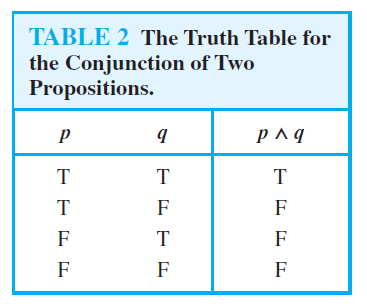
* 1. **Propositional Logic**
* **Proposition:** A statement that declares a fact that is either true or false, but not both.
* **Propositional Variables:** Variables that represent propositions, e.g. p, q, r, s…
* **Truth Value:** The truth value of a proposition is denoted by T, if the proposition is true and F, if the proposition is false.
* **Propositional Logic:** Area of logic that deals with propositions. Developed by Aristotle.
* **Compound propositions:** Found from existing propositions using logical operators.

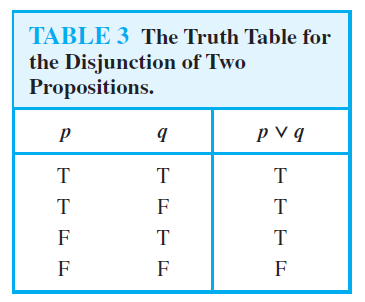
**Definition 1:** Let p be a proposition. The negation of p, denoted by ~p (read as not p) is the statement that “It is not the case that p.” The truth value of ~p is the opposite of the truth value of p.



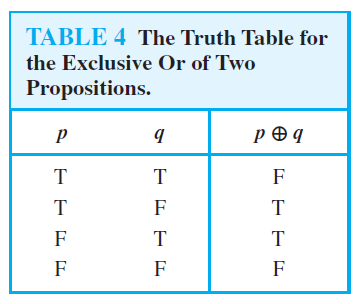
**Definition 2:** Let p and q be propositions. The conjunction of p and q, denoted by p˄q is the proposition p and q. It is true when both p and q are true and is false otherwise.



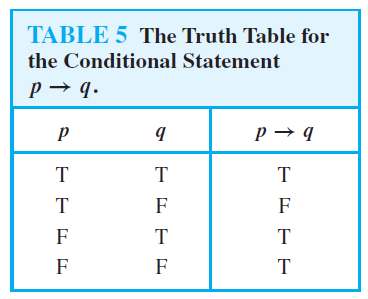
**Definition 3:** Let p and q be propositions. The disjunction of p and q, denoted by p˅q is the proposition p (inclusive) or q. It is false when both p and q are false and is true otherwise.



**Definition 4:** Let p and q be propositions. The exclusive or of p and q, denoted by pꚛq is the proposition p (exclusive) or q. It is true if exactly one of p and q is true and false otherwise.

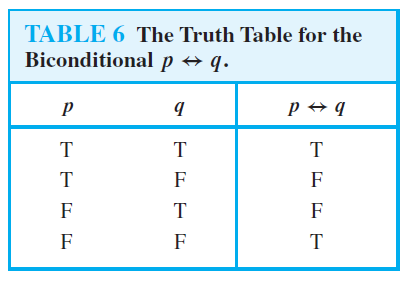


**Definition 5:** Let p and q be propositions. The conditional statement or implication p->q is the proposition “if p, then q”. It is false when p is true, and q is false and is false otherwise. p is called the hypothesis, antecedent or premise and q is called the conclusion or consequence.

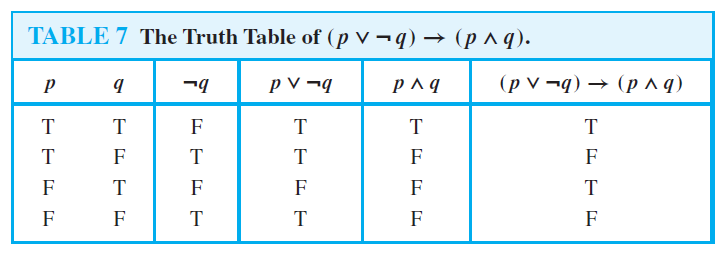


* **Converse:** The converse of p->q is q->p.
* **Contrapositive:** The contrapositive of p->q is ~q->~p.
* **Inverse:** The inverse of p->q is ~p->~q.
* The main statement and its contrapositive are ***equivalent*** (always have the same truth value).
* The inverse and converse are equivalent.

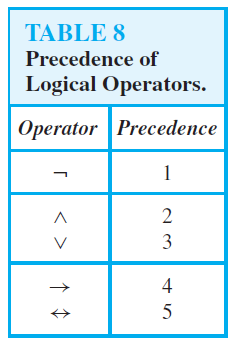
**Definition 6:** Let p and q be propositions. The biconditional statement or bi-implication p<->q is the proposition “p if and only if q”. It is true when p and q have the same truth values and is false otherwise.



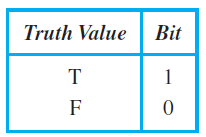
* **Truth tables of compound propositions:** These truth tables can be built step-by-step to produce the final expected results.



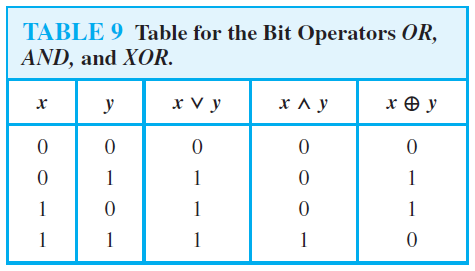
* **Precedence of logical operators:** To perform calculations seamlessly and for the ease of readability, when equations with multiple operators have no parentheses, the following precedence rule follows –



* **Bit:** A symbol with two possible values, namely, 0 and 1. It is used to represent truth values.
* 1 represents T or true
* 0 represents F or false



* **Boolean variable:** A variable whose value is either true or false. It can be represented using bits.
* **Bit operations:** These refer to logical connectives like OR, AND, and XOR.



**Definition 7:** A bit string is a sequence of zero or more bits. The length of the string is the number of bits in the string. E.g. 101010011 is a bit string of length 9.

**Exercises**

1. **Which of these sentences are propositions? What are the truth values of those that are propositions?**
   1. **Boston is the capital of Massachusetts.**
   2. **Miami is the capital of Florida.**
   3. **2 + 3 = 5.**
   4. **5 + 7 = 10.**
   5. **x + 2 = 11.**
   6. **Answer this question.**

* *“Boston is the capital of Massachusetts” is a sentence that proposes a fact. Hence, it is a proposition. The truth value of this proposition is true.*
* *“Miami is the capital of Florida” is a sentence that proposes a fact. Hence, it is a proposition. The truth value of this proposition is false.*
* *“2 + 3 = 5” is a sentence that proposes a fact. Hence, it is a proposition. The truth value of this proposition is true.*
* *“5 + 7 = 10” is a sentence that proposes a fact. Hence, it is a proposition. The truth value of this proposition is false.*
* *“x + 2 = 11” is not a proposition because it can be either true or false depending on the value of x.*
* *“Answer this question” is not a proposition because it is neither true nor false.*

1. **Which of these are propositions? What are the truth values of those that are propositions?**
   1. **Do not pass go.**
   2. **What time is it?**
   3. **There are no black flies in Maine.**
   4. **4 + x = 5.**
   5. **The moon is made of green cheese.**
   6. **2n ≥ 100.**