# CS2020A Discrete Mathematics

## Tutorial 05 | 08/Sep/2025

1. Identify the atomic propositions in the following statements, denote them by distinct propositional variables and express the whole statement as a propositional formula.
   a) You can be happy with out being rich

   b) You cannot be happy unless you are rich
   c) You cannot be both happy and rich
   d) A happy place is a healthy place
   e) If this statement is false then it is true
2. Identify the atomic propositions in the following statements, denote them by distinct propositional variables and express the **intended meaning** of the statement as a propositional formula.
   a) You will catch your bus if you run.
      (*Answer*:
      - $p$: "you run"
      - $q$: "you will catch your bus"
      - intended meaning: $p \to q$ )

   b) You will catch your bus only if you run.
   c) You will not catch your bus unless you run
   d) You may not catch your bus unless your run
   e) To catch the bus, it is necessary that you run
   f) To catch the bus, it is sufficient that you run
   g) You will catch the bus if and only if your run.

   Group the logically equivalent statements into the same group. How many groups did you get?

3. Negate the following propositions and write the result in plain English

   a) Both India and Pakistan can beat Australia in cricket.
   b) If India can beat England, then Pakistan can also beat England.
   c) India can beat England only if Pakistan can beat England.
   d) Neither India nor Pakistan can beat Australia in cricket.

4. Establish the following Logical Equivalences using Truth Tables.

   a) $p \wedge (q \vee r) \equiv (p \wedge q) \vee (p \wedge r)$
   b) $p \vee (q \wedge r) \equiv (p \vee q) \wedge (p \vee r)$
   c) $\neg(p \wedge q) \equiv \neg p \vee \neg q$
   d) $\neg(p \vee q) \equiv \neg p \wedge \neg q$
   e) $(p \to q) \wedge (p \to r) \equiv p \to (q \wedge r)$
   f) $(p \to r) \wedge (q \to r) \equiv (p \vee q) \to r$
   g) $(p \to q) \vee (p \to r) \equiv p \to (q \vee r)$
   h) $(p \to r) \vee (q \to r) \equiv (p \wedge q) \to r$

5. For each of the propositional formulae below, draw its parse tree and list all the subformulae (Every node of the parse tree gives a subformulae). For examples $p$, $q$, $(p \vee q)$, $r$, $\neg r$ and $(p \vee q) \wedge \neg r$ are subformulae of $(p \vee q) \wedge \neg r$.

   a) $\neg(s \to (\neg(p \to (q \vee \neg s))))$ (You'll get 9 distinct subformulae)
   b) $((p \to \neg q) \vee (p \wedge r) \to s) \vee \neg r$ (You'll get 11 distinct subformulae)