3. (a) (2 marks) Give a recursive definition of the set $\mathcal{S}_P$ of propositional formulas that can formed using the ternary predicate $P : \{T, F\}^3 \to \{T, F\}$ and the propositional variable X.

   Solution:

   (b) (8 marks) Let $M : \{T, F\}^3 \to \{T, F\}$ be the ternary predicate that is true when 0 or 1 of its arguments are true and is false when 2 or 3 of its arguments are true.
   Use structural induction to prove that every formula in $\mathcal{S}_M$ is logically equivalent to X or is logically equivalent to $\text{NOT}(X)$.

   Solution:

   (c) (8 marks) Let $N : \{T, F\}^3 \to \{T, F\}$ be the ternary predicate that is true when 0 of its arguments are true and is false when at least 1 of its arguments is true.
   Prove that every unary predicate $U : \{T, F\} \to \{T, F\}$ is logically equivalent to some formula in $\mathcal{S}_N$.

   Solution:

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