[CS M51A FALL 18] Solution to QUIZ 2

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Duration: 30 minutes

11/2/2018

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1. Problem 1a (15 Points)

   State true or false or cannot conclude from information provided. If false give a counter example.

   (a) A maxterm must include all input variables (2pt)

   (b) A canonical product of sums is a product of minterms (2pt)

   (c) To reduce an incompletely specified function to a sum of products form, the dont cares are always assumed to be zero for best results (2pt)

   (d) Pushing a bubble from the output of a logic gate towards the inputs always transforms the gate (2pt)

   (e) In a K-map, non-essential primes are a proper subset of essential primes (2pt)

2. Problem 1b (5 Points) Prove OR gate is not universal

Solution

1. Problem 1a

   (a) A maxterm must include all input variables (2pt)
   True

   (b) A canonical product of sums is a product of minterms (2pt)
   False (A canonical product of sums is a product of maxterms)

   (c) To reduce an incompletely specified function to a sum of products form, the dont cares are always assumed to be zero for best results (2pt)
   False (Take the two variable boolean function $f(x, y)$ with $f(0, 0) = 0$, $f(1, 1) = 1$ and $f(0, 1)$ and $f(1, 1)$ being don't cares).

   (d) Pushing a bubble from the output of a logic gate towards the inputs always transforms the gate (2pt) False ($AND(x', y') = x'y' = (x + y)' = NOT(OR(x, y))$ and so transforms AND to $NAND$ while $XOR(x', y') = x'y + xy' = XOR(x, y)$ and so XOR remains).

   (e) In a K-map, non-essential primes are a proper subset of essential primes (2pt) False (clear from their definitions).

2. Problem 1b:

   OR is not a universal function, and this can be seen most easily by noting that it is monotonic increasing; in other words, that in any nested OR function, once you get a 1, you will always have a 1. Thus you could never implement a NOT gate with nested OR functions: giving a 0 to a NOT gate gets you a 1.