1999 Paper 2 Question 3

Digital Electronics

In an edge triggered flip flop, explain what is meant by

(a) hold time

(b) setup time

(c) delay from clock edge to output   [3 marks]

What relation should hold between two of these quantities to provide sensible behaviour and why?   [5 marks]

Comment on the possibility and desirability of negative hold times.   [2 marks]

Each of the following boolean functions is a function of the four variables w, x, y, z. The functions are not totally specified and may take on any value for certain inputs. f_n indicates where the function must be true, while g_n is true where the value of the function is not constrained. Draw maps and provide a minimum sum of products form for each of the functions.

(a) $f_1 = \bar{w}\bar{x}\bar{y}z + \bar{w}x\bar{y}z + \bar{w}xy\bar{z} + wx\bar{y}\bar{z} + wx\bar{y}z + wxy\bar{z}$

     $g_1 = \bar{w}\bar{x}y\bar{z} + \bar{w}x\bar{y}\bar{z}$

(b) $f_2 = \bar{w}\bar{x}\bar{y}\bar{z} + \bar{w}\bar{x}\bar{y}z + \bar{w}x\bar{y}\bar{z} + \bar{w}x\bar{y}z + \bar{w}xy\bar{z} + \bar{w}xyz + w\bar{x}\bar{y}z + w\bar{x}yz + wxyz$

     $g_2 = w\bar{x}y\bar{z} + wxy\bar{z}$

[5 marks]

Let $f(x_0, x_1, \ldots, x_{n-1})$ be equal to 1 if and only if exactly k of the variables have the value 1. How many prime implicants does this function have?   [5 marks]