

UCR CS220, Fall 2005
Synthesis of Digital Systems
Prof. Harry Hsieh
Homework #4

Due Tuesday, December 6th, 9:30AM, electronically. Please show all steps.

1. (15 points) Let $x=ace+bce+de+g$, $y=ad+bed+cde+ge$
 - a. Using algebraic division, compute the kernel set for both x and y
 - b. Form the auxiliary function for computing KERNEL intersection.
 - c. What are the meaningful co-kernel of the auxiliary function? Extract the largest one.
 - d. Extract the largest common kernel between x and y , and rewrite x and y by substituting in the common kernel.

2. (15 points) Consider the logic network defined by the following expressions:
$$x = ad' + a'b' + a'd' + bc + bd' + ac$$
$$y = a + b$$
$$z = a'c' + a'd' + b'c' + b'd' + e$$
$$u = a'c + a'd + b'd + e'$$
 - a. Perform the algebraic division fx/fy and show all steps
 - b. Compute all kernels and co-kernels of z and u
 - c. Extract a multiple-cube subexpression common to fz and fu . Show all steps, redraw the network graph

3. (15 points) Given the following logic network, where a, b, c are input and x is output
 - a. What are the CDC for f ?
 - b. What are the ODC for f ?
 - c. Minimize f using these don't care's.
$$d = b$$
$$e = a' + d'$$
$$f = c \oplus a$$
$$x = f + e$$

4. (15 points) Consider the following logic network.

$$\begin{aligned} o &= e g \\ e &= (a+b)' \\ g &= c+d \\ d &= a+b \end{aligned}$$

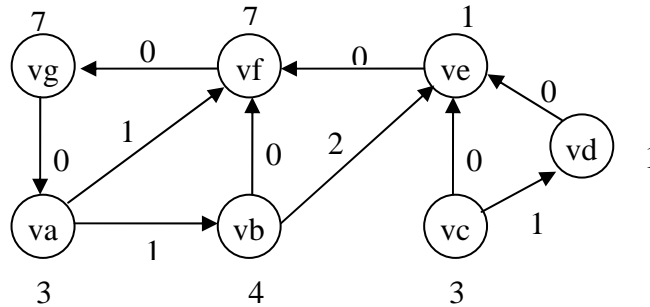
where inputs are $\{a,b,c\}$ and they all arrive at time 0, while the output is $\{o\}$.

Assume unit delay on all the gates (nor, and, or)..

- What is the topological critical path?
- Determine whether or not the path is a true critical path by dynamic sensitization.
- What changes in input can cause the longest delay for the output to change? Draw the timing diagram. (i.e. which value go from 0 to 1 or 1 to 0, and when).

5. (15 points) Given the following circuit

- What is the longest path delay
- Retime the graph to try to get the delay down to 14.



6. (20 points) Given the following library elements and their static delay cost:

- INV(1)
- AND2(2)
- NOR2(2)
- NAND3 (3)
- AOI21(4)

- Draw pattern tree for each element using NOR2 and INV base functions.
- Draw the subject tree for the following o using NOR2 and INV base functions.

$$\begin{aligned} o &= (y+z)' \\ y &= (ab)' \\ z &= (x+d)' \\ x &= (b+c)' \end{aligned}$$

- Use dynamic programming. Find optimum delay covering of the subject graph by pattern graphs. Show all steps.