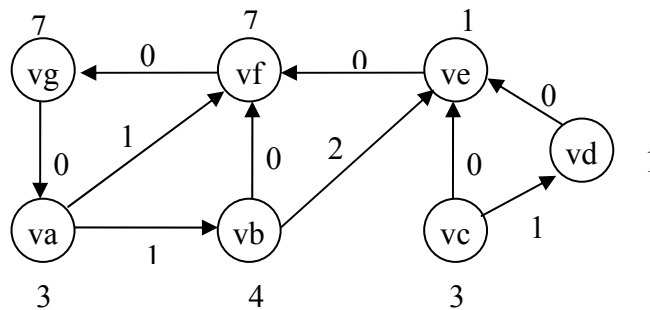


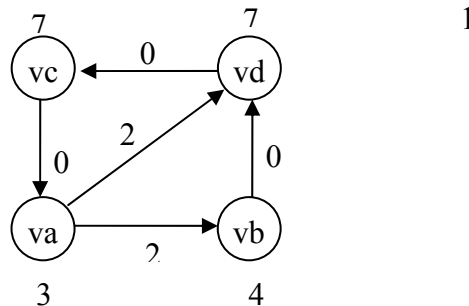
UCR CS220, Fall 2006
 Synthesis of Digital Systems
 Prof. Harry Hsieh
Homework #4

Due Tuesday, December 5th, 9:30AM, electronically. Please show all steps.

1. (10 points) Given the following circuit
 - a. What is the longest path delay
 - b. Retime the graph to try to get the delay down to 14.



2. (10 points) Given the following circuit
 - a. What is the longest path delay?
 - b. Retime the graph to try to get the delay down to 10.



3. (20 points) Given the following library elements and their static delay cost:

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

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

$$o=(y+z)'$$

$$y=(ab)'$$

$$z=(x+d)'$$

$$x=(b+c)'$$

- c. Use dynamic programming. Find optimum delay covering of the subject graph by pattern graphs. Show all steps.
4. (20 points) Given the following library elements and their static area and delay cost: (area,delay)

INV(50, 1)
 AND2(60, 2)
 NOR2(70, 2)
 NAND3 (80, 4)
 AOI21(90, 5)

(And-Or-Invert, 2 inputs are and-ed, then nor with 3rd input)

- a. Draw pattern tree for each element using NAND2 and INV base functions.
 b. Draw the subject tree for the following o using NAND2 and INV base functions.
 $o=(y+z)'$
 $y=(ab)$
 $z=(c+d)'$
- c. Use dynamic programming. Find optimum area covering of the subject graph by pattern graphs.
 d. Use dynamic programming. Find optimum delay covering of the subject graph by pattern graphs.
5. (5 points) Given 4 accelerators for some given application:
 a. Under what circumstances would it makes sense to couple all accelerators tightly. Why is it beneficial to couple all the accelerators tightly?
 b. Under what circumstances would it makes sense to couple all accelerators loosely. Why is it beneficial to couple all the accelerators loosely?
6. (5 points) Given 4 accelerators with the following characteristics:

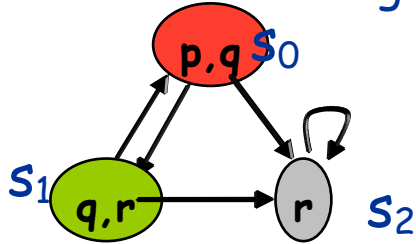
| | a_1 | a_2 | a_3 | a_4 |
|-----------|-------|-------|-------|-------|
| Max Freq: | 1000 | 800 | 400 | 100 |
| Cycles: | 50 | 10 | 20 | 100 |

derive the X(A,C) table. According to the dynamic programming algorithm, what is the best clock partitioning if we have 3 clock frequencies available?

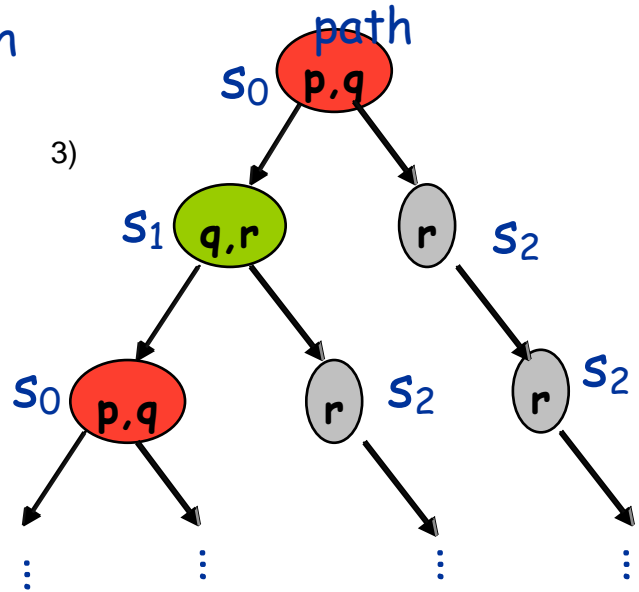
7. (10 points)
 a. Given variable order [x1, x3, x2, x4], use ROBDD operations to compute the ROBDD encoding the function $f: f = x1'x2'x3'x4' + x1'x2'x3x4' + x1x2'x3'x4 + x1'x2x3'x4'$
 b. Repeat using variable order [x1, x3, x4, x2].

8. (10 points) Given model M and its computation path:

Model specified as state transition graph



Infinite computation path



Does the following CTL query hold on the model? Explain your answer.

- a. $M, s_0 \models A[p \cup r]$?
- b. $M, s_0 \models AG[p \vee q \vee r \rightarrow EF EG r]$?