EE290LS - Midterm 2

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NAME:

problem	maximum points	your points
problem 1	20	
problem 2	20	
problem 3	20	
problem 4	20	
problem 5	20	
total	100	

1. Consider the following two algebraic expressions.

$$
\begin{aligned}
F &= acf + ad'ef + bcf + bd + bd'ef + cd \\
G &= ae + acd + be + ef'
\end{aligned}
$$

   (a) Generate all the kernels of F and G. For each kernel, give its level and a co-kernel.

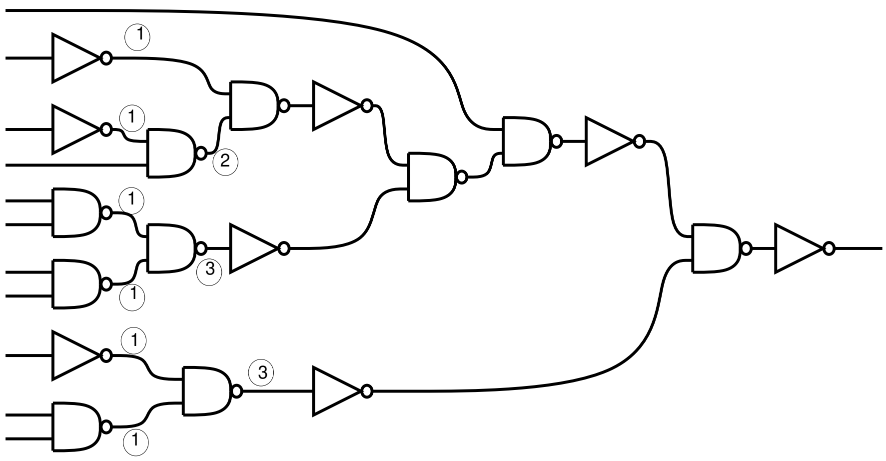
   (b) Determine if there is a multiple-cube common subexpression of F and G from the result of (a) ? If yes, represent F and G using the common subexpression.

   (c) Generate all the two-cube algebraic divisors of F and G.

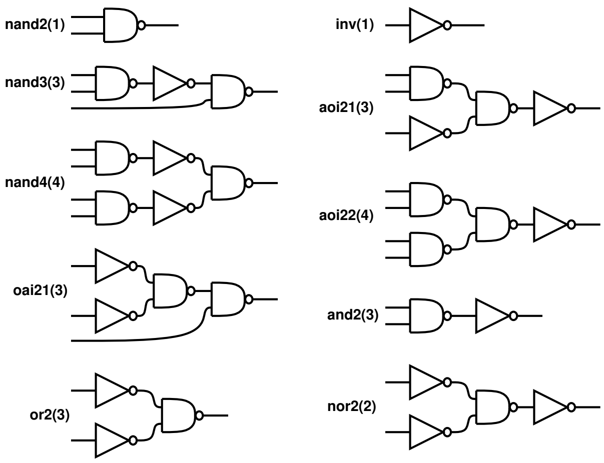
   (d) Repeat (b) using the result of (c).

2. Apply the dynamic-programming-based tree covering algorithm to find the area-optimum technology mapping of the subject graph below with the following pattern graphs. Show how you can cover the subject graph optimally. Note that the number in the parentheses of each pattern graph is its cost. (Hint 1: The circled number attached to a gate is the cost of the optimum tree covering up to the gate. Hint 2: Note that only some of pattern graphs are useful.)

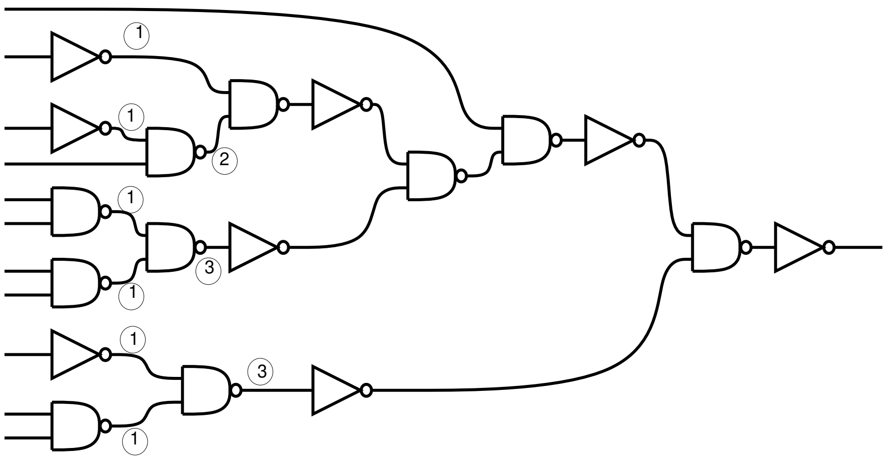
   Subject graph:



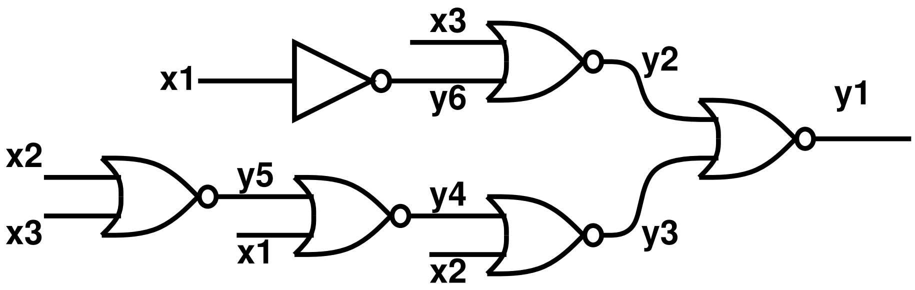
   Pattern graphs:


nand2(1)
nand3(3)
nand4(4)
oai21(3)
or2(3)
inv(1)
aoi21(3)
aoi22(4)
and2(3)
nor2(2)

Use the following graph to show an optimum solution.



3. Consider the following NOR network.



(a) Use the Transduction method to compute the CSPF of $y_i (i = 1, \dots, 6)$ in terms of **primary inputs**. Use the following linear order.

$$y_1 < y_2 < y_3 < y_4 < y_5 < y_6 < x_1 < x_2 < x_3$$

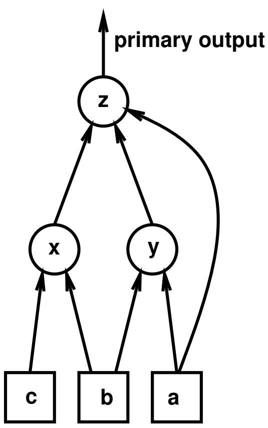
(b) There is another NOR implementation of this function with one less number of gates. Derive such an implementation using the result of (a). (Hint: The CSPF of y_6 gives useful information.)

x_1	0	0	0	0	1	1	1	1
x_2	0	0	1	1	0	0	1	1
x_3	0	1	0	1	0	1	0	1
y_1								
y_2								
y_3								
y_4								
y_5								
y_6								
CSPF(y_1)								
CSPF(y_2)								
CSPF(y_3)								
CSPF(y_4)								
CSPF(y_5)								
CSPF(y_6)								

4. Consider the following single-output Boolean network where

$$\begin{aligned} x &= b \oplus c \\ y &= a + b \\ z &= y + xa' \end{aligned}$$

Our goal is to minimize node x **without changing the functionality of nodes y and z.**



(a) Compute the *complete* don't care set necessary to minimize node x. Assume that the external don't care set of this network is ab.

(b) List all the functions allowed at node x under the condition that their minimal variable supports are exactly the same as before, i.e. b and c.

5. You are given two combinational circuits. Devise an algorithm which checks to see if the two networks are *functionally equivalent* using **testing techniques**. The algorithm should return yes if the networks are equivalent. Otherwise it should return an input pattern the application of which makes the circuits distinguishable at the primary outputs. Apply your algorithm to the following circuits and give the correct output of your algorithm.