CSE140: Components and Design Techniques for Digital Systems

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Where we are now

• What we’ve covered so far
  – Number representations, CMOS transistor design, CMOS logic gates
  – Boolean algebra, NAND/NOR only circuits
  – SOP and POS, Logic minimization using K-maps
  – Multilevel logic implementation
  – Mux, Demux, Encoder, Decoder, Adders, Comparators, Shifters

• What comes next:
  – Review for the exam today

• Exam
  – Bring one page 8 ½ x 11”, handwritten notes on both sides
    • Pencil, eraser & your ID
  – Exam is graded out of 100pts and has 10 bonus points
  – Assigned seating

• Discussion session:
  – Wednesday

• Prof. office hour moves from Th to Wed at 2pm
CMOS problem

- Write the truth table for a circuit consisting of gates and transistors

Transistor circuit is:
A) NAND
B) NOR
C) NOT
D) OR
E) None of the above
Primes and Essential Primes

Given the following function:

\[ F(A,B,C,D) = \sum m(0,2,6,7,8,10) + \sum d(1,11,12,15) \]

a) List all prime implicates
b) Identify the essential prime implicates
c) Give min cover in POS form

Is this function fully specified?
A) Yes
B) No
A component of ALU

This design has:
A. 2 inputs & 1 output
B. 4 inputs & 1 output
C. 3 selector inputs
D. B. & C.
E. None of the above
Design an ALU bit slice using the specification given below with max 2 FAs.

<table>
<thead>
<tr>
<th>$S_1$</th>
<th>$S_0$</th>
<th>ALU Operation</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>$F_i = (A_i == B_i)$</td>
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<tr>
<td>0</td>
<td>1</td>
<td>$F_i = (A_i &lt; B_i)$</td>
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<td>1</td>
<td>0</td>
<td>$F_i = A_i + B_i + 1$</td>
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<tr>
<td>1</td>
<td>1</td>
<td>$F_i = A_i - B_i - 1$</td>
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Mystery Gate

• What should the mystery gate be so that output F matches the following Boolean equation:
  \[ F = ABC'D + AB'CD' + A'BCD' + A'B'C'D' \]
Word problem

Design a line controller \((L)\) for an assembly line that has 3 fail safe sensors and one emergency switch. The line should keep moving unless any of the following conditions arise:

- If the emergency switch is pressed
- If the sensor1 and sensor2 are activated at the same time.
- If sensor2 and sensor3 are activated at the same time.
- If all the sensors are activated at the same time
Function minimization: show $F = B' + A$

$$F(A,B,C) = A' B' C' + A' B' C + A B' C' + A B' C + A B C' + A B C$$
Conversion to NOR gates

• Use De Morgan’s:
  – $A' + B' = (A \cdot B)'$
  – $A' \cdot B' = (A+B)'$
NAND gates implementation

\[ A = (X + ((\overline{Y})(Z)))(Y + Z) \]
More K-maps

Given the following function:

\[ F(A, B, C, D) = \sum m(2, 4, 7, 9, 10, 11, 14) + \sum d(3, 6, 12) \]

a) List all prime implicants
b) Identify the essential prime implicants
c) Give min cover in SOP form
K-map from Boolean Algebra

\[ F = (A \ XOR \ C) \ B \ D + (A + C) \ B \ D + \bar{A} \bar{B} \ D + B \bar{C} \bar{D} \]
Design problem – distance between numbers

- Design a circuit that gives the absolute distance between the two numbers (e.g. $x=3 \ y=1 \ d=2$)

<table>
<thead>
<tr>
<th>$x_1$</th>
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<th>$y_1$</th>
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<th>$d_1$</th>
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$d_1$: $x_1x_0$

$d_0$: $y_1y_0$