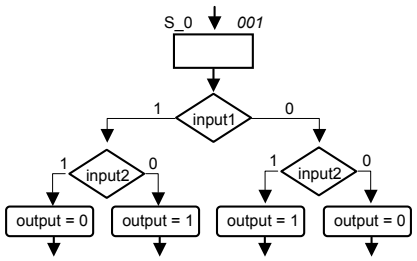
PRACTICE PROBLEM SET 5
ASM Charts and Logic Optimization

1. Which function does the ASM in Figure 1 describe?
   (a) Half Subtractor Borrow Bit
   (b) 2-to1 MUX
   (c) Half Subtractor Difference Bit
   (d) 2-input XOR gate
   (e) none of the above

Fig 1: ASM example used in Problem 1



2. Describe the functionality of a 3-input OR gate using an ASM chart.

3. Which of the following equations are in sum-of-minterms form?
   (a) F(a, b, c) = 1
   (b) F(a, b, c) = ∑m(1, 2, 3) + ∑d(6)
   (c) F(a, b, c) = ab + a'b'
   (d) F(a, b, c) = abc

4. Implement the following equations using gates (do not optimize the equations). What is the size and area for each circuit?
   (a) F = a'
   (b) F = ab + c'
   (c) F = a(b'c' + d) + bd'

5. Plot the following design options on the following graph. Which of the following solutions represent a pareto points?
   (a) Option A {area = 10, delay = 1 }
   (b) Option B {area = 2, delay = 2 }
   (c) Option C {area = 4, delay = 8 }
   (d) Option D {area = 8, delay = 9 }
   (e) Option E {area = 1, delay = 8}
   (f) Option F {area = 5, delay = 4 }
   (g) Option G {area = 1, delay = 5}
   (h) Option H {area = 9, delay = 6}

6. Use DeMorgan's Law to find the inverse of the following equations. Provide you answer in sum-of-products form.
   (a) F(a, b, c, d) = a' + b + c'd
   (b) F = a'bc' + ab

7. Given F(a, b, c) = ab + ac + a'b'c
   (a) List the variables in F
   (b) List the literals in F
   (c) List the product terms in F
   (d) List the minterms in F

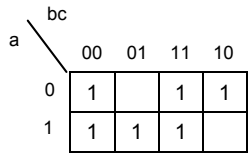
8. Consider the equation F(a,b,c, d) = ∑m(4, 5, 7, 12, 14, 15). Which of the following product terms are prime implicants of the equation (*Hint: draw a K-map*).

   (a) a'bc'd'
   (b) ab'c
   (c) ad'
   (d) bc'd'
   (e) There are no prime implicants in this equation.

9. Using the K-map provided in Fig2, identify

   (a) minterms
   (b) implicants
   (c) prime implicants
   (d) essential prime implicants

Fig 2: K-map used in Problem 9.



10. What is the difference between an exact algorithm and a heuristic?

11. Perform two-level logic optimization for F(a, b, c, d) = a'b'c'd' + a'c'd' + a'cd' + bcd' + acd'

    (a) Using K-maps, express your solution in sum-of-products form
    (b) Using Boolean Algebra, express your solution in sum-of-products form

12. Perform two-level logic optimization for F(a, b, c, d) = ∑(0, 2, 6, 8, 9, 10, 13, 15).

13. Using Quine-McCluskey (tabular minimization method) minimize F(a, b, c) = ∑m(1, 2, 3, 4, 6, 7).

14. Using Quine-McCluskey (tabular minimization method) minimize F(a, b, c) = ∑m(0, 2, 3, 4, 5, 7).

15. Using Petrick's method, determine the minimum cover of the following prime implicants chart.

Fig 3: Prime Implicants Chart used in Problem 15.

			2	3	7	10	14	15
P1	001-	(2, 3)	x	x				
P2	-010	(2, 10)	x			x		
P3	0-11	(3, 7)		x	x			
P4	-111	(7, 15)			x			x
P5	1-10	(10, 14)				x	x	
P6	111-	(14, 15)					x	x

16. Petrick's method utilizes the absorption property (X + XY = X) to determine the minimum cover. Prove the absorption property works *(NOTE: THIS DOES NOT NEED TO BE A FORMAL PROOF)*.

17. How could you change Petrick's method if the size of the prime implicants was taken into consideration (i.e. Size of a'b'c' is 6 transistors vs. ab is only 4 transistors).