PRACTICE QUESTIONS

LECTURE 4, 5 AND 6

1. Simplify the following switching expressions
   a. x’+y’+xyz’
   b. xy+wxyz’+x’y
   c. (x’+xyz’) +(x’+xyz’) + (x’+xyz’)
   d. a+a’b+a’b’c+a’b’c’d+….
   e. x’y’z+yz+xz

2. Find the complement of the following expressions
   a. x’(y’+z’) (x+y+z’)
   b. (x+y’z’) (y+x’z’) (z+x’y’)
   c. w’+(x’+y+y’z’) (x+y’z)

3. A safe has five locks v, w, x, y and z, all of which must be unlocked for the safe to open. The keys to the locks are distributed among five executives in the following manner:
   Mr. A has keys for locks v and x
   Mr. B has keys for locks v and y
   Mr. C has keys for locks w and y
   Mr. D has keys for locks x and z
   Mr. E has keys for locks v and z

   a. Determine the minimum number of executives to open the safe.
   b. Who is the essential executive without whom the safe cannot be opened?
   c. Find all the combinations of executives that can open the safe.

4. Using a four variable K map derive the minimum sum-of-products expressions for the following functions

a. $f1(w,x,y,z)=\Sigma(0,1,2, 3,4,6,8,9,10,11)$

b. $f2(w,x,y,z)=\Sigma(0,1,5,7,8,10,14,15)$

c. $f3(w,x,y,z)=\Sigma(0,2,4,5,6,8,10,12)$

5. Given the function $T(w,x,y,z)=\Sigma(1,2,3,5,13)+\Sigma_\phi(6,7,8,9,11,15)$
   a. find a minimal SOP expression
   b. find a minimal POS expression

6. For the function $T(w,x,y,z)=\Sigma(0,1,2,34,6,7,8,9,11,15)$
   a. Draw the Karnaugh map
   b. Find all prime implicants and indicate which are essential.

7. Using Karnaugh map, derive minimal product-of-sums expressions for the following functions:

   a. $f(w,x,y,z) = \sum (0,1,2,3,4,6,8,9,10,11)$

   b. $f(w,x,y,z) = \sum (0,1,5,7,8,10,14,15)$

   c. $f(w,x,y,z) = \sum (0,2,4,5,6,8,10,12)$

   d. $f(w,x,y,z) = \sum (0,2,4,9,12,15) + \sum\phi (1,5,7,10)$

   e. $f(w,x,y,z) = \sum (1,2,3,5,13) + \sum\phi (6,7,8,9,11,15)$

8. A binary-coded-decimal (BCD) message appears in four input lines of a switching circuit. Design an AND, OR, NOT gate network that produces an output value 1 whenever the input combination is 0, 2, 3, 5 or 8.

9. For the following functions,

   (i) use the map to find all prime implicants

   (ii) (ii) indicate which of the prime implicants are essential.

a. f(w,x,y,z) = $\sum$ (0,1,2,3,4,6,7,8,9,11,15)

b. f(w,x,y,z) = $\sum$ (1,3,4,5,7,8.9.11.14,15)

10. Using Karnaugh map, derive minimal product-of-sums expressions for the following functions:

    a. f(w,x,y,z) = $\sum$ (0,1,2,3,4,6,8,9,10,11)

    b. f(w,x,y,z) = $\sum$ (0,1,5,7,8,10,14,15)

    c. f(w,x,y,z) = $\sum$ (0,2,4,5,6,8,10,12)

    d. f(w,x,y,z) = $\sum$ (0,2,4,9,12,15) + $\sum\phi$ (1,5,7,10)

11. Write the Boolean expression for a properly labelled block diagram of a 2:1 multiplexer (MUX). Implement (most optimally) the 2:1 MUX using

    (a) basic logic gates only

    (b) NAND gates only

    (c) NOR gates only

12. Consider the function: f(A, B, C, D) = (AD + AC)[B(C + BD)]

    (a) Draw its schematic using AND, OR, and NOT gates.

    (b) Using Boolean algebra, put the function into its minimized form and draw the resulting schematic.

13. Consider the functions:

    f1(A, B, C, D) = Σm(0, 1, 2, 7, 8, 9, 10, 15)

    f2(A, B, C, D) = Σm(1, 2, 3, 5, 8, 13)

    (a) Write them as Boolean expressions in canonical minterm form.

    (b) Rewrite the expressions in canonical maxterm form.

    (c) Write the complement of f1 and f2 in “little m” notation and as canonical minterm expressions.

(d) Write the complement of f1 and f2 in “big M” notation and as canonical maxterm expressions.

14. Consider the function: $f(A, B, C) = AB + B'C' + AC'$

    (a) Write this as a Boolean expression in canonical minterm form.

    (b) Write the complement of the function as a canonical minterm expression.

    (c) Rewrite this expression in canonical maxterm form.

15. Write the truth table for the following functionality:

    A 2-bit wide shifter takes two input signals i0 and i1, and shifts them to two outputs o0 and o1, under the control of a shift signal. If this signal SHIF T is false, then the outputs are equal to their corresponding inputs. If SHIF T is true, then o1 is equal to i0, and o0 is set a 0.

16. Find the dual of the following expressions:

    (a) $f(A, B, C, D) = [A + (BCD)'][(AD)' + B(C' + A)]$

    (b) $f(A, B, C, D) = AB'C + (A' + B + D)(ABD' + B')$

17. Simplify the following expressions using laws of Boolean algebra:

    (a) $W(A, B, C) = A'BC' + A'BC + AB'C' + AB'C$

    (b) $X(A, B, C) = A'B'C' + A'BC + AB'C' + ABC$

    (c) $Y(A, B, C, D) = A'B'C'D' + A'B'CD' + AB'C'D' + AB'CD + ABC'D' + ABCD$

18. Using the method of perfect induction, validate

    $(a \oplus b) \oplus c = (a \oplus b) \oplus c = (a \oplus b) \odot c$

19. Write the 4-bit binary representation for all unsigned numbers in ascending order. In a similar fashion, write their corresponding gray code sequence. Compute the number of bit flips that take place while transitioning from one codeword to the next, individually for both the sequences. Express the number of transitions as a function of n, where n is the number of bits used for representation. Comment on the reduction achieved in the number of bit flips when Gray code sequence is adopted over binary code sequence.

20. Compute the number of switching functions possible for a p-variable Boolean function. Justify