

INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR  
Computer Science and Engineering  
Switching Circuits and Logic Design (CS21002)  
Assignment – 1 (Spring)

Group: \_\_\_\_\_

Marks: 60

**Answer ALL the questions using xournal or similar software to edit the PDF**

1. Simplify the following boolean functions in sum of products form using the Karnaugh map.
  - (a)  $f_1(w, x, y, z) = \sum(0, 2, 4, 5, 6, 7, 8, 10, 13, 15)$  3
  - (b)  $f_2(w, x, y, z) = \sum(0, 1, 5, 7, 8, 10, 14, 15)$  3
  - (c)  $f_3(w, x, y, z) = \sum(2, 3, 12, 13, 14, 15)$  3
2. Simplify the following boolean functions in product of sum form using the Karnaugh map.
  - (a)  $g_1(w, x, y, z) = \prod(1, 3, 5, 7, 13, 15)$  3
  - (b)  $g_2(w, x, y, z) = \prod(1, 3, 6, 9, 11, 12, 14)$  3
  - (c)  $g_3(w, x, y, z) = \prod(1, 4, 5, 6, 11, 12, 13, 14, 15)$  3
3. Given the function:  $h(w, x, y, z) = \sum(1, 2, 3, 5, 13) + \sum_{\phi}(6, 7, 8, 9, 11, 15)$ 
  - (a) Find the minimal sum of products expression 3
  - (b) Minimal product of sum expression 3
4. 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. 4
5. Simplify the following functions and implement them using two level NAND gate circuits.
  - (a)  $F_1(A, B, C, D) = A' + B + D' + B'C$  3
  - (b)  $F_2(A, B, C, D) = (A' + C' + D')(A' + C')(C' + D')$  3
6. Using the Karnaugh map simplify the following function.  
 $f(v, w, x, y, z) = \sum(3, 6, 7, 8, 10, 12, 14, 17, 19, 20, 21, 24, 25, 27, 28)$ . 3
7. Given the function  $T(w, x, y, z) = \sum(1, 3, 4, 5, 7, 8, 9, 11, 14, 15)$ :
  - (a) Using the Karnaugh map find all the prime implicants and identify the essential ones 3
  - (b) Find three distinct minimal expressions for  $T$  3
8. Draw the Karnaugh map for a four variable function with even number of prime implicants of which exactly half are essential. 4
9. How many prime implicants are there for the function  $f(x_1, x_2, \dots, x_n)$  which assumes the value 1 if and only if  $k$  or more of the variables are equal to 1. 4
10. Use the Quine-McCluskey procedure to generate the set of prime implicants and obtain *all* minimal expressions for the following functions:
  - (a)  $h_1(w, x, y, z) = \sum(1, 5, 6, 12, 13, 14) + \sum_{\phi}(2, 4)$  3
  - (b)  $h_2(w, x, y, z) = \sum(0, 1, 5, 7, 8, 10, 14, 15)$  3
  - (c)  $h_2(v, w, x, y, z) = \sum(1, 5, 6, 7, 9, 13, 14, 15, 17, 18, 19, 21, 22, 23, 25, 29, 30)$  3