INDRAPRASTHA INSTITUTE OF INFORMATION TECHNOLOGY, DELHI
ECE111 DC

TUTORIAL 3

(Answer any 9 out of 12 Questions, 7th Question is a compulsory Question)

Total Marks: 10

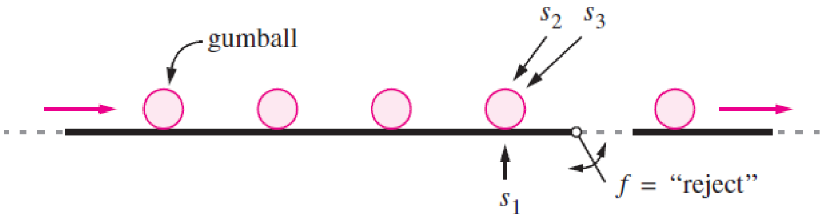
1. Convert the following decimal numbers into binary (1 marks)
    a. $(17)_{10}$
    b. $(33)_{10}$
    c. $(130)_{10}$
    d. $(2560)_{10}$
2. What is the minimum number of bits needed to represent the following decimal numbers in binary? (1 marks)
    a. $(270)_{10}$
    b. $(520)_{10}$
    c. $(780)_{10}$
    d. $(1029)_{10}$
3. Prove the validity of the logic equation (1 marks)
    i. $(x_1 + x_3).(\overline{x_1} + \overline{x_3}) = x_1 \bullet \overline{x_3} + \overline{x_1} \cdot x_3$
    ii. $x_1 \bullet \overline{x_3} + x_1 \bullet x_3 + \overline{x_2} \cdot \overline{x_3} + \overline{x_2} \bullet x_3 = x_1 + \overline{x_2}$
4. Implement the following logic function: (1 marks)
    i. $F(x_1, x_2) = x_1 \bullet x_2 + \overline{x_1} \bullet \overline{x_2} + \overline{x_1} \bullet x_2$
    ii. $F(s_1, s_2, s_3) = \overline{s_1} \bullet \overline{s_2} \cdot s_3 + \overline{s_1} \cdot s_2 \cdot s_3 + s_1 \bullet \overline{s_2} \cdot s_3 + s_1 s_2 \overline{s_3} + s_1 s_2 s_3$
5. Use algebraic manipulation to prove following: (1 marks)
    i. $(x + y) \cdot (x + y) = x + y$
    ii. $x \cdot y + y \cdot z + x \cdot z = x \cdot y + x \cdot z.$

6. Determine whether or not the following expressions are valid, i.e., whether the left- and right-hand sides represent the same function. (1 marks)

    (a) $\overline{x}_1 x_3 + x_1 x_2 \overline{x}_3 + \overline{x}_1 x_2 + x_1 \overline{x}_2 = \overline{x}_2 x_3 + x_1 \overline{x}_3 + x_2 \overline{x}_3 + \overline{x}_1 x_2 x_3$
    (b) $x_1 \overline{x}_3 + x_2 x_3 + \overline{x}_2 \overline{x}_3 = (x_1 + \overline{x}_2 + x_3)(x_1 + x_2 + \overline{x}_3)(\overline{x}_1 + x_2 + \overline{x}_3)$
    (c) $(x_1 + x_3)(\overline{x}_1 + \overline{x}_2 + \overline{x}_3)(\overline{x}_1 + x_2) = (x_1 + x_2)(x_2 + x_3)(\overline{x}_1 + \overline{x}_3)$

7. Figure 1 depicts a part of a factory that makes bubble gumballs. The gumballs travel on a conveyor that has three associated sensors s_1, s_2, and s_3. The sensor s_1 is connected to a scale that weighs each gumball, and if a gumball is not heavy enough to be acceptable then the sensor sets $s_1 = 1$. Sensors s_2 and s_3 examine the diameter of each gumball. If a gumball is too small to be acceptable, then $s_2 = 1$, and if it is too large, then $s_3 = 1$. If a gumball is of an acceptable weight and size, then the sensors give $s_1 = s_2 = s_3 = 0$. The conveyor pushes the gumballs over a “trap door” that it used to reject the ones that are not properly formed. A gumball should be rejected if it is too large, or both too small and too

light. The trap door is opened by setting the logic function f to the value 1. By inspection, we can see that an appropriate logic expression is $f = s_1 s_2 + s_3$. Use Boolean algebra to derive this logic expression from the truth table and implement the logic function using AND, OR and NOT gate. (2 marks)



(a) Conveyor and sensors

Figure 1

8. Design the simplest sum-of-products circuit that implements the function (1 marks)

    i. $f(x, y, z) = \sum m(3, 4, 6, 7)$

    ii. $f(x, y, z) = \sum m(1, 3, 4, 6, 7)$

9. Design the simplest product-of-sums circuit that implements the function (1 marks)

    i. $f(x, y, z) = \prod M(0, 2, 5)$.

    ii. $f(x, y, z) = \prod M(0, 1, 5, 7)$

10. Derive the simplest sum-of-products expression for the function (1 marks)

$$f(w, x, y, z) = w \cdot \overline{y} \bullet \overline{z} + x \cdot \overline{y} \cdot z + w \cdot \overline{x} \bullet \overline{y}$$

11. Derive the simplest product-of-sums expression for the function (1 marks)

$$f(w, x, y, z) = (w + y + z) \bullet (x + y + z) \bullet (w + x + y)$$

12. Design the simplest circuit that has three inputs, x_1, x_2, and x_3, which produces an output value of 1 whenever two or more of the input variables have the value 1; otherwise, the output must be 0. (1 marks)