**Introduction to Computer Organisation and Architecture**

**Tutorial 5: Digital Logic Circuit**

1. Demonstrate by means of truth tables the validity of the following identities of Boolean algebra:

Consensus theorem for two variables

x**.**y + x'**.**z= x**.**y + x'**.**z + y.z

(x+y)**.**(x'+z) = (x + y)**.**(x’ + z).(y + z)

1. Design a logic circuit that converts a 3-bit signed number in sign-and-magnitude format into the equivalent 3-bit number in two’s complement format. Express your solution in terms of sum-of-minterms and product-of-maxterms.
2. Design a combinational circuit to detect an error (invalid input) in the representation of a decimal digit in BCD.

[Hint: Draw a digital circuit whose output is equal to 1 when the inputs contain any one of the six unused bit patterns in the BCD code.

1. Write a Boolean expression for each of the logic diagrams below. Then, using the DeMorgan’s theorem, simplify the circuit. Redraw the circuit.





1. Design a multiply-by-7 circuit as follows, the input is a 2-bit number; and the output is a 5-bit number which is the product of AB and 7.

**Extra Questions**

1. Show that the logic expression *cn*⊕*cn*-1 is a correct indicator of overflow in the addition of 2’s-complement integers, by using an appropriate truth table.
2. Two 2-bit numbers *A=a1a0* and *B = b1b0* are to be compared by a four-variable function *f(a1, a0,b1,b0)*.
   1. The function *f* is to to have a value 1 whenever

*v(A) ≤ v(B)*

where*v(X) = x1 x 21 + x0 x 20*for any 2-bit number. Assume that the variables A and B are such that |*v(A) – v(B)|* ≤ *2*. Synthesize *f* using as few gates as possible.

* 1. The function *f* = 1 whenever

*V(A) > v(B)*

subject to the constraint

*v(A) + v(B) ≤ 4*