Practical Session Week 1A

Objectives

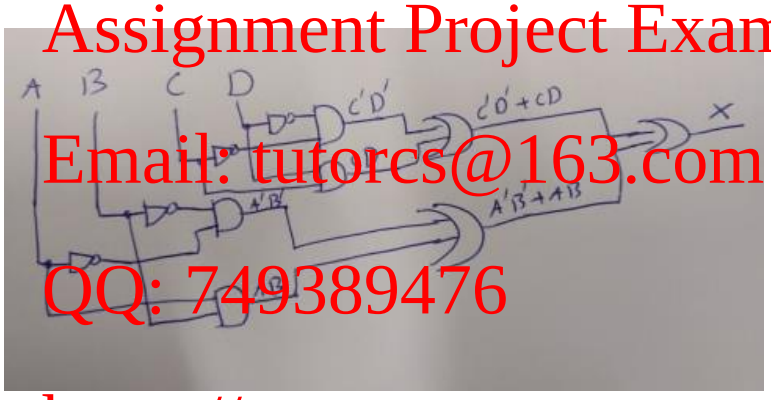
1. To draw the l olean expressions
2. To write dow ons of given circuit diagrams
3. To find Boole

Tasks

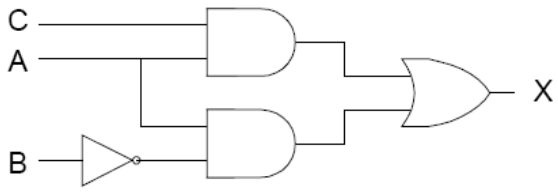
1. Draw the logic gate circuit corresponding to the following Boolean expression

$F = (\bar{A} . \bar{B} + A . B) + (C' . D' + C . D)$

Answer:



2. Write the Boolean expression of the following circuit diagram. Set up the truth table

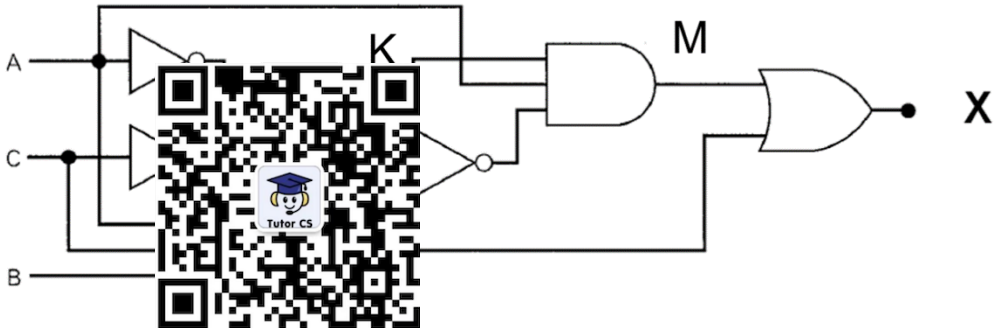


Answer: X = C.A + A.B'

Table 1. Truth Table for Task 2

A	B	C	B'	C . A	A . B'	X
0	0	0	1	0	0	0
0	0	1	1	0	0	0
0	1	0	0	0	0	0
0	1	1	0	0	0	0
1	0	0	1	0	1	1
1	0	1	1	1	1	1
1	1	0	0	0	0	0
1	1	1	0	1	0	1

3. Write the Boolean expression of the following circuit diagram. Set up the truth table



Answer: X = (A' . C')' . A . B' + A . C . B

or equivalently, **X = M + L, where M = K . A . B' , L = A . C . B , K=(A' . C')'**

Table 2. Truth Table for Task 3

A	B	C	A'	B'	C'	K	L	M	X
0	0	0	1	1	1	0	0	0	0
0	0	1	1	1	0	1	0	0	0
0	1	0	1	0	1	0	0	0	0
0	1	1	1	0	0	1	0	0	0
1	0	0	0	1	1	1	0	1	1
1	0	1	0	1	0	1	0	1	1
1	1	0	0	0	1	1	0	0	0
1	1	1	0	0	0	1	1	0	1

4. Compare X of exercise 2 and exercise 3. Keep in mind that the Boolean expression of X in exercise 3 can be simplified to the one of exercise 2.

Answer (not assessed):

(A'.C')' . A.B' + A.C.B = *// Apply DeMorgan Theorem: (A.B)'=A'+B' and (A+B)'=A'.B'*

= (A + C).A.B' + A.C.B = // Distributive Law – permits the factoring out of an expression

= A.A.B' + C.A.B' + A.C.B = // Idempotent Rule

= A.B' + C.A.B' + A.C.B = // Absorptive Law – absorbing like terms

= A.B' + C.A(B'+B) = //complement Rule

= A.B' + C.A

5. Find the Boolean expression of function *f(x,y,z)* with three inputs and one output; *f(x,y,z)* produces 1 when at least two of the inputs are 1, otherwise it produces 0.

Step1: set up the truth table

x	y	z	*f (x, y, z)*
0	0	0	**0**
0	0	1	**0**
0	1	0	**0**
0	1	1	**1**
1	0	0	**0**
1	0	1	**1**
1	1	0	**1**
1	1	1	**1**

Step2: find all the Boolean sub-expressions only when *f(x,y,z)=1, e.g., when (x=0,y=1,z=1).* The sub-expression is generated by inverting the inputs with zero and keeping the rest as they are, e.g., the subexpression for *(x=0,y=1,z=1) is x'yz.*

***Answer**: x'yz, xy'z, xyz', xyz*

Step3: *f(x,y,z)* is given by summing (applying logical OR) all the sub-expressions found in step2.

***Answer**: f = x'yz + xy'z + xyz' + xyz*

Step4 (this step is optional and will **not be assessed**): Simplify f(x,y,z) using Boolean algebra. For those who are interested in how to simplify Boolean expressions, they can read the following link (Karnaugh maps) https://www.geeksforgeeks.org/k-mapkarnaugh-map/

Answer: this is out of the scope of this lab session

6. Revisit and study the 4-bit ripple carry adder shown in the slides. Draw the circuit for an 8-bit ripple carry adder