ENGR 101
Engineering Technology

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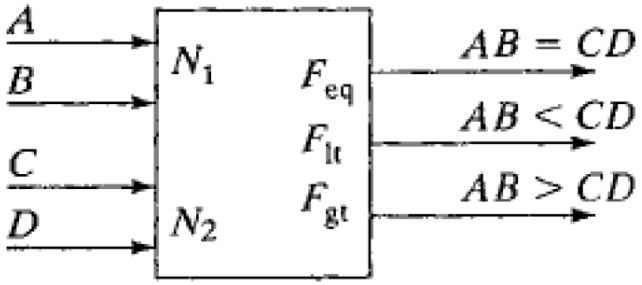
Week 15: The Big Review

- Logic
  - Logic Gates
  - Boolean Theorems
  - K-Maps

Exercise 1: Boolean Logic

We want to design a circuit which compares two 2-bit numbers, N_1 and N_2, and generates three outputs F_{eq}, F_{lt} and F_{gt}. F_{eq} is TRUE when $N_1=N_2$, F_{lt} is TRUE when $N_1<N_2$ and F_{gt} is TRUE if $N_1 > N_2$. This is shown in the Figure below. Number N_1 is expressed by bits A and B, and number N_2 is expressed by bits C and D. A and C are the most significant bits (MSB).



- **Produce a truth table for Feq, Flt, Fgt**
- **Simplify Feq, Flt, Fgt using Boolean Theorems**
- **Simplify Feq, Flt, Fgt using Kmaps**
- **Draw a circuit diagrams for Feq, Flt, Fgt**

Exercise 2: Boolean Logic

- Design a logic circuit to check if a 5-bit binary number is a factor of 5. The output will only be high when the binary number is a factor of 5.
  - Produce a Truth Table
  - Write the SOP and simplify

A	B	C	D	E	Output
0	0	0	0	0	
0	0	0	0	1	
0	0	0	1	0	
0	0	0	1	1	
0	0	1	0	0	
0	0	1	0	1	1
0	0	1	1	0	
0	0	1	1	1	
0	1	0	0	0	
0	1	0	0	1	
0	1	0	1	0	1
0	1	0	1	1	
0	1	1	0	0	
0	1	1	0	1	
0	1	1	1	0	
0	1	1	1	1	1
1	0	0	0	0	
1	0	0	0	1	
1	0	0	1	0	
1	0	0	1	1	
1	0	1	0	0	1
1	0	1	0	1	
1	0	1	1	0	
1	0	1	1	1	
1	1	0	0	0	
1	1	0	0	1	1
1	1	0	1	0	
1	1	0	1	1	
1	1	1	0	0	
1	1	1	0	1	
1	1	1	1	0	1
1	1	1	1	1	

Exercise 3:

$$X = \overline{C + D} + \bar{A}C\bar{D} + A\bar{B}\bar{C} + \bar{A}\bar{B}CD + AC\bar{D}$$

- Simplify X using Theorems of Boolean Algebra
- Simplify X using K-maps
- Draw a circuit diagram using as few gates as possible

Exercise 4: LED logic

We want to design a logic circuit for a 7-segment LED display shown below.

The inputs are 4 binary digits **d**, **c**, **b**, **a**, which represent the number to be displayed on the LED. Bit **d** is the most significant bit (MSB), and **a** is the least significant bit (LSB).

Design the logic to drive LED segment F and draw the circuit diagram.