School of Computer Science
Faculty of Science

COMP-2650: Computer Architecture I: Digital Design
Winter 2021

Assignment#	Date	Title	Due Date	Grade Release Date
Lec05	Week 05	**XOR, XNOR**	Feb. 09, 2021 Tuesday Midnight AoE Wednesday 7 AM EDT	Feb. 15, 2021

The objectives of the lecture (weekly) assignments are to practice on topics covered in the lectures as well as improving the student's critical thinking and problem-solving skills in ad hoc topics that are closely related but not covered in the lectures. Lecture assignments also help students with research skills, including the ability to access, retrieve, and evaluate information (information literacy).

Lecture Assignments Deliverables

You should answer 2 of the below questions based on your preference using an editor like MS Word, Notepad, and the likes or pen in papers. You have to write and scan the papers clearly and merge them into a single file in the latter case. In the end, you have to submit all your answers in one single pdf file `COMP2650_Lec05_UWinID.pdf` containing the following items:

1. Your name, UWinID, and student number
2. The question Id for each answer. Preferably, the questions should be answered in order of increasing Ids. *Please note that if your answers cannot be read, you will lose marks.*
3. Including the questions in your submission pdf file is optional.

Please follow the naming convention as you lose marks otherwise. Instead of UWinID, use your own UWindsor account name, e.g., mine is hfani@uwindsor.ca, so, my submission would be: `COMP2650_Lec05_hfani.pdf`

Lecture Assignments
(select only 2 questions based on your preference)

1. **eXclusive-OR (XOR)**, denoted by the symbol $\oplus$, is a logical operation that performs the following Boolean operation:

$$x \oplus y = xy' + x'y$$

   XOR is 1 if x and y are the complements of each other. Using truth table or Boolean postulates, prove that XOR is:

   a. Commutative: $x \oplus y = y \oplus x$
   a. Associative: $x \oplus (y \oplus z) = (x \oplus y) \oplus z = x \oplus y \oplus z$

2. Prove that XOR is not distributive over AND, i.e., $x \oplus (yz) \neq (x \oplus y)(x \oplus z)$

3. Prove the followings:
   a. $x \oplus 0 = x$
   b. $\mathbf{x \oplus 1 = x'}$ (very useful)

c. $x \oplus x = 0$
d. $x \oplus x' = 1$
e. $x \oplus y' = x' \oplus y$

4. Design XOR using NAND gates only.

5. Prove or disprove $x \oplus y = x' \oplus y'$

6. XOR is said to be **odd function** since, in the general case, given *n* input binary variables it outputs 1 if an odd number of input variables are 1. Using truth table, show this for *n*=4, i.e., $F = x \oplus y \oplus z \oplus w$. Then, show it in the 4-variable K-map.

7. **eXclusive-NOR (XNOR)**, also known as **equivalence**, performs the following Boolean operation:

$$x \odot y = xy + x'y'$$

   As seen, the XNOR is equal to 1 if both x and y are equal. Show that XNOR is the complement of the XOR, i.e., $(x \oplus y)' = x \odot y$

8. Prove or disprove $(x \oplus y \oplus z)' = x \odot y \odot z$