Department of Computer Engineering
Faculty of Engineering, University of Peradeniya

CO221 : Digital Design
Lab 6 - Prelab

- Each individual should have a written/printed pre-report.
- No need to waste your time unnecessarily on neatness.
- Write down the intermediate steps while you solve the problem.
- If you need help put a post in the forum for CO221 in FEeLS rather than copying from someone else.
- If you are caught copying you get 0 for the prelab and also the marks for the rest of the lab would be reduced by 50%.

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1. Briefly explain why NAND and NOR gates are called universal gates. (One or two sentences would suffice)

2. Doing a design only using universal gates may sometimes complicate the circuit, but yet it is advantageous. State a such important advantage.

3. Show how all the other logic functions (NOT, AND, OR, NOR, XOR) can be implemented by **only using NAND** gates by drawing a logic circuit for each logic function.

4. Show how all the other logic functions (NOT, AND, OR, NAND, XOR) can be implemented by **only using NOR** gates by drawing a logic circuit for each logic function.

5. Implement the full adder circuit. The full adder has 3 inputs A , B , C_{in} where A , B are the input bits of the numbers and C_{in} is the carry in. There are 2 outputs S and C_{out} where S is the sum bit and C_{out} is the carryout.
    a. Draw the truth table.
    b. Draw the Karnaugh maps.
    c. Derive the simplest Boolean equations.
    d. Draw the logic circuit by using **2-input NOR gates** only.

6. Design a binary to BCD converter. Let the input be a 4-bit binary number ABCD. Let the output PQRS be the 4-bit BCD representation. Please note that input values only from 0-9 have BCD representations. For input values from 10-15 which are invalid, you should use don't cares.
    a. Draw the truth table.
    b. Draw the Karnaugh maps.
    c. Derive the simplest Boolean equations.
    d. Draw the logic circuit by only using **2-input and/or 3-input NAND gates**.

7. Design a comparator circuit that compares the magnitude of two 2-bit numbers (AB and CD). It should have a 3-bit output PQR indicating AB>CD, AB=CD and AB<CD respectively.
    a. Draw the truth table.
    b. Draw the Karnaugh maps.
    c. Derive the Boolean equations that uses minimum number of gates.
    d. Draw the logic circuit by only using **2-input and/or 3-input NAND gates**.