1. **(Modified 1-bit Comparator Module)** In class, we have briefly discussed the modified 1-bit comparator module which can be used as a building block for multi-bit arithmetic comparators. The inputs of the module are the data input bits $x$ and $y$, and the control input bits $E_{in}$, $L_{in}$, and $G_{in}$ (these three bits indicate the status of the magnitude of the $n$-bit binary numbers $X$ and $Y$ in the bit positions to the left of current bit). The outputs of the module are the status output bits $E_{out}$, $L_{out}$, and $G_{out}$ (these three bits indicate the status of the magnitude of the binary numbers $X$ and $Y$ in the bit positions to the left of the current bit and including the current bit).

(a) Write down the truth table for the 1-bit comparator module.

(b) Determine the SOP expression for the outputs and then draw the corresponding circuit diagram. (If you use Espresso, you also need to include your Espresso file and the output.)

2. **(Design of MUX using Tri-state Buffers)** Build a 4-to-1 MUX using some tri-state buffers. Clearly draw your result.

3. **(Modular Approach for Algorithmic Statements)** A circuit has two 8-bit positive signed numbers $X$ and $Y$ and an 1-bit number $sel$ as inputs. Construct circuits that yield the correct value of the 8-bit output $Z$ for the following algorithmic statements by using only the building blocks presented in class. Clearly draw the schematic containing the building blocks and their connections.

   (a) if $(sel==0)$ then $Z=X$ else $Z=Y$

   (b) if $(sel==0)$ then $Z=X+Y$ else $Z=Y-X$

   (c) if $(X<=Y)$ then $Z=X+X$ else $Z=Y+Y$

   (d) if $(sel==1$ and $X<=14)$ then $Z=X+15$ else $Z=X$

4. **(Modular Approach for Building a 3-bit Modulo-5 Adder)** Build a 3-bit modulo-5 adder. The inputs of the modulo-3 adder are two 3-bit unsigned binary numbers $A = a_2a_1a_0$ and $B = b_2b_1b_0$ ($A$ and $B$ are only taking values which corresponds to decimal numbers 0,1,2,3,4). The output of the adder are a 3-bit data output $S = s_2s_1s_0$ which corresponds to the modulo-5 sum of $A$ and $B$, and a carry-out bit $c_{out}$ which equals 1 only when the actual decimal sum of $A$ and $B$ exceeds 4. Clearly draw the schematic containing the building blocks and their connections.

5. **(Modular Approach for Building a 4-bit Saturation Adder)** Problem 10 of Section 4.8 in text (pages 78-79). Clearly draw the schematic containing the building blocks and their connections.