1.

The adder has inputs A, B, X and Ci. The sum outputs are set depending on the number of inputs that are high.

The truth table for the adder is

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>X</th>
<th>Ci</th>
<th>Si_{i+2}</th>
<th>Si_{i+1}</th>
<th>Si</th>
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</table>
From the truth table we solve for each of the sum outputs using Kmap.

There can be different solutions depending on the level of optimization.

\[ S_{i+1} = AB\bar{X} + \overline{ABC_i} + \overline{AB}X + \overline{X\bar{C}}B + \overline{X\bar{C}}A + ABX + A\bar{B}X + AB\bar{C}_i + \overline{X\bar{C}}A + \overline{AXC_i} \]
\[ S_i = AB \bar{X} C_i + \bar{A}B \bar{X} \bar{C}_i \]
\[ + \bar{A}B \bar{X} C_i + \bar{A}B X \bar{C}_i \]
\[ + AB \bar{X} C_i + AB X\bar{C}_i \]
\[ + \bar{A}B X \bar{C}_i + \bar{A}B X C_i \]

\[ S_{i+2} = ABX C_i \]
2. Gate level Implementations

There can be different solutions depending on the level of optimization
Using De Morgan’s laws to convert to NAND NOR INVERT

(The outputs of the inverters have been marked with intermediate numbers for convenience of labeling wires in the solution of Q 3)
3. Transistor level implementation of the sum outputs of the adder.
(Please note: the wires numbered 1 through 10 are the intermediate outputs shown in the solution of Q2)
4. Compound Gate Implementation
Pull up section for Si+1

Pull down section for Si+1
Pull up section for Si
5. Stick diagram for a 7 input NOR gate

6. The Boolean function for the circuit that has high output when the value of the input is greater than or equal to 7
7. The compound gate implementation of the Boolean function in Q6

Boolean Function = $A_4 \neg A_3 A_2 A_1$
Number of transistors with standard gate solution = 2 (inverter) + 8 (4 input NAND) + 4 (2 input NAND) = 14

Number of transistors with compound gate solution = 12
Gate Level of Mux with Boolean function
(S3 S2 S1 are the select lines and A4-A0 are the input lines, Again the intermediate outputs have been labeled from 1-5 for convenience of labeling in Q9)

\[ \text{Out} = \overline{S_3} \overline{S_2} \overline{S_1} A_0 + \overline{S_3} \overline{S_2} S_1 A_1 + \overline{S_3} S_2 \overline{S_1} A_2 \\
+ \overline{S_3} S_2 S_1 A_3 + S_3 \overline{S_2} \overline{S_1} A_4 \]

Transistor Level of Mux
Latch with Asynchronous set and reset
Please look at the screen capture for the commands to be entered

Command to make folder – `mkdir HW1`

Text editing command – `emacs &`

Save in the HW1 directory by specifying path as shown at the bottom of the screen capture
For changing the directory use command – cd HW1
For searching use command ls -l joshi* (yourlastname)
See result below
3098M404: Node has been upgraded to a Sun Fire 2840 with 128 processor
threads and 64 GB of memory. Contact ucsd.edu and addu.edu are
also time-sharing hosts available within the Student Computing
facility.

3594M29: All users of this computer system acknowledge that activities on it
are subject to the UCR policies.

aludru@ucsd.edu(3): cd 144
aludru@ucsd.edu(4): cd 145
aludru@ucsd.edu(5): cd 1AM
aludru@ucsd.edu(6): ls -l joshu.txt
aludru@ucsd.edu(7):