Open book and open notes, 90-minute examination. No electronic devices are permitted.

Page 1) 10 points ________________ Page 2) 18 points ________________

Page 3) 18 points ________________ Page 4) 18 points ________________

Page 5) 18 points ________________ Page 6) 18 points ________________

TOTAL ________________ of 100

Re-grade requests must be handed in the day exams are returned in class. Write the problem number you wish reviewed. A maximum of three problems is allowed for review.

1A. What is the largest value in decimal for 10 bits unsigned? ____________________________ (2 pt.)

1B. Write -100 decimal as a 10 bit signed binary number ____________________________ (2 pt.)

2. Perform the following binary additions and subtractions by hand. Show all your work below.
   Assume the numbers are all unsigned binary. (2,2,2 pt.)

   \[
   \begin{align*}
   &111111 + 101101 + 101101 \\
   &1100100 - 1011111 \\
   &1011.101 \times 10.010
   \end{align*}
   \]
3. Directly synthesize a circuit for the following equation using only 2 Input NOR gates. (8 pt.)

\[ Y = (A + B + C) (B \cdot \overline{C} + D) \quad ; \quad A.L, B.H, C.L, D.H, Y.L \quad \textbf{Do Not Simplify the} \]

4. Find the minimum sum of products and minimum product of sums for the logic equation below using a K-Map. (10 pt.)

\[ Y = \overline{W} \cdot X \cdot \overline{Y} \cdot Z + \overline{X} \cdot Z + \overline{W} \cdot X \cdot \overline{Z} + W \cdot X \cdot \overline{Z} + \overline{W} \cdot X \cdot \overline{Y} \cdot Z \]

\[ \begin{array}{c}
\text{Y} \\
\text{Z}
\end{array} \]

- \( Y \) (MSOP) = 

- \( Y \) (MPOS) = 
5. Create a circuit for the following equation using 3 input OR gates, 3 input AND gates and Inverters. The solution employing the least number of gates will receive the maximum points. Do not simplify. (8 pt.)

\[ Y = (X + \overline{W*Z}) \times (\overline{W*Z} + V) \]; Y.H, X.L, W.H, Z.L, V.L  Do Not Simplify the Equation!

6. Derive the logic equations for the following signals listed after the circuit below.

W.H = ___________________________________________________________ (6 pt.)

Y.L = ____________________________________________________________ (2 pt.)

Z.H = ____________________________________________________________ (2 pt.)
7. Derive the logic equations for the following signals listed after the circuit below. Show all intermediate signals as low true for partial credit purposes. DO NOT SIMPLIFY YOUR ANSWER!

Z.L = ________________________________________________________________ (6 pt.)

Y.H = ________________________________________________________________ (2 pt.)

8. Simplify the equation below with De Morgan’s Rule and Boolean Identities to find the MSOP. (10 pt.)

\[
P = \left(\overline{X+Z}\right)\left(\overline{X+Z+N}\right)\left(\overline{X+Y+W}\right) + \left(\overline{X+Y+W}\right)\left(\overline{X+Z}\right)\left(\overline{X+Y+W+N}\right)
\]

P = ________________________________________________________________ MSOP
9. For the Logic Equations below, fill in the inputs and outputs to complete the circuit diagram also shown below. Hint: Use Captain DeMorgan's Theorem to re-write Z.L. Note: Both the 8:1 Mux and 3:8 Decoder have high true inputs, outputs and select lines. (12 pt.)

\[
Y = A \cdot \overline{B} \cdot C \cdot \overline{D} \cdot \overline{E} \cdot F \cdot \overline{G} \quad ; Y.H
\]

\[
Z = (A + B + C + D + E + F + G)(\overline{A} + B + C + D + \overline{E} + \overline{F} + \overline{G}) \quad ; Z.L
\]

10. Fill in the LOGIC timing diagram for \( Y \) below. Assume the circuit above is used and that both devices have a 5 nsec propagation delay. (6 pt.)
11. Design a device that divides A1:0 by B1:0. A1:0 and B1:0 are unsigned and all I/O are high true. You should create a 5 bit answer, Result4:0 (R4:0), where there are fractional bits in R4:0. Therefore, chose the number of bits you will require for integer and then use the remaining bits to represent the fractional portion of the answer. Also, create an Infinity output bit (I) that goes true when the division results in infinity.

Fill in the Truth Table Below (best solution = highest points):

<table>
<thead>
<tr>
<th>A1</th>
<th>A0</th>
<th>B1</th>
<th>B0</th>
<th>R4</th>
<th>R3</th>
<th>R2</th>
<th>R1</th>
<th>R0</th>
<th>I</th>
</tr>
</thead>
</table>

Derive the Logic Equations for R4, R2 and I in MSOP form (3 pt.):

R4 = ________________________________

R2 = ________________________________

I = ________________________________

Show the circuits required for R4, R2 and I (3 pt.):