Digital Circuits
Midterm, Tuesday May 2nd

Instructions:

- You have **two hours**, 7PM - 9PM
- The exam has 3 questions, totaling 100 points.
- You are allowed to carry the textbook, your own notes and other course related material with you. Electronic reading devices [including cell phones, ipads, laptops, etc.] are not allowed.
- You are required to provide a detailed explanation of how you arrived at your answers.
- Good Luck!

1. **Mix of Questions** *(40 points)*
Answer the following 8 questions. Simple reasoning will be enough. Each of them worth 5 points.

   (a) Covert the binary number $1011.01_{(2)}$ to decimal.

   (b) Add binary numbers $101.011_{(2)} + 11.101_{(2)}$ (Your answer should be a binary number as well).

   (c) Determine the 2's complement of 10011000.

   (d) Construct a truth table of $X = \bar{A}B + AB\bar{C} + \bar{A}\bar{C} + A\bar{B}C$.

(e) Convert $X = \overline{AB(\overline{C}D + EF)}$ to sum-of-product (SOP) form.

(f) Implement a logic circuit for $X = AD + B\bar{C}$.

(g) For the full-adder with input $A = 0$, $B = 1$, $C_{in} = 1$, determine the outputs Σ and C_{out}.

(h) Design a simple decoder that detects the presence of the binary code 0110.

Extra Pages for Problem 1.

2. Karnaugh Map *(30 points)*

Let $X = \overline{(A + B\overline{C})(AC + \overline{D})} + \bar{A}B\bar{C}\bar{D}$.

(a) Develop a truth table of X. *(10 points)*
(Hint: You can simplify the formula first)

(b) Use a Karnaugh map to reduce X to a minimum SOP form. *(10 points)*

(c) Use a Karnaugh map to reduce X to a minimum POS form. *(10 points)*

Extra Pages for Problem 2.

3. **Functions of Combinational Logic** *(30 points)*

(a) For the multiplexer in Figure 1, input states are given by $D_0 = 1, D_1 = 1, D_2 = 0, D_3 = 0$. Then, determine the output waveform when the data-select inputs are sequenced as shown by the waveforms in Figure 2. *(15 points)*

Figure 1: Multiplexer.

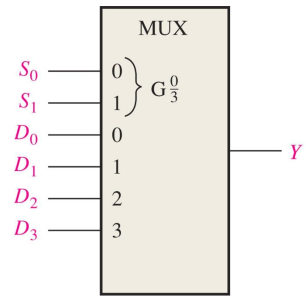
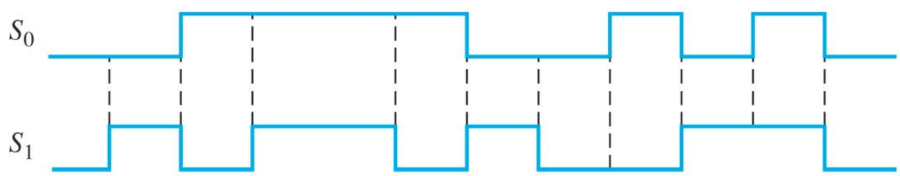
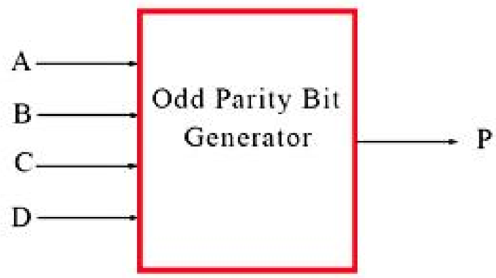


Figure 2: Data-Select Input Waveforms.



(b) Suppose you have two 4-bit odd parity generators as decribed in Figure 3. This 4-bit odd parity generators outputs 1 if even numbers of inputs are 1 and outputs 0 if odd numbers of inputs are 1. For example, the output is $P = 1$ if $A = 1, B = 0, C = 1, D = 0$, and the output is $P = 0$ if $A = 1, B = 0, C = 1, D = 1$. Construct 8-bit odd parity generator using two 4-bit odd parity generators with one additional logic gate. *(15 points)*
(Hint: Again, 8-bit odd parity generator outputs 1 if even number of inputs are 1 and outputs 0 if odd numbers of inputs are 1)

Figure 3: Data-Select Input Waveforms.



Extra Pages for Problem 3.