Midterm# 1

Thur., Oct. 16, 2014, at 9:45AM 10:55am, in class.
Open books and notes – anything on paper. No electronic aids allowed *except* for laptops or tablets to display electronic copies of the text by Roth. You are not allowed to display *anything* else on a laptop or tablet. No phones.

1. **Conversion Between Different Number Representations** [12 pts.]

   (a) Convert the following binary numbers to decimal [1 pts.]:

      i. 101.101

   (b) Convert the following decimal numbers to binary [1 pts.]. Truncate after 12 bits beyond the binary point.

      i. 666.666

   (c) Perform the following number conversions [1 pts]:

      i. Binary 10100011011101111011010011 10 to hexadecimal

      ii. Hexadecimal 67AC789AB6BF786 to binary.

   (d) Perform the following number conversions[3 pts]:

      i. 665_7 (base 7) to base 5

   (e) Give the negative of the following numbers in two's complement notation (length is 8 bits) [3 pts].

      i. 11101111

      ii. 00010000

   (f) Suppose that the following bits represent positive and negative numbers in two's complement notation. Perform the operation indicated, keeping the length at 8 bits. Give the result in binary [3 pts].

      i. $11111110_2 + 00111111_2$.

      ii. $00111111_2 \times 11111110_2$.

2. **Boolean Functions, Truth Tables, Logic Minimization, Two-Level Forms and Binary Decision Diagrams** [40 pts.]

   Consider a boolean function $f(a, b, c, d)$. Suppose that the function is 1 if

   - There is a single 1 among the inputs, or
   - There is a single 0 among the inputs, or
   - There are exactly two 1's among the inputs

   and it is 0 otherwise.

   (a) Write down a truth table for the function [2 pts.]

   (b) Using a Karnaugh map, provide a minimal sum-of-products (AND-OR) expression. [3 pts.]

   (c) Using a Karnaugh map, provide a minimal product-of-sums (OR-AND) expression. [3 pts.]

   (d) Provide a minimal NAND-NAND expression [2 pts.].

   (e) Provide a minimal OR-NAND expression [2 pts.].

   (f) Provide a minimal NOR-OR expression [2 pts.].

   (g) Provide a minimal NOR-NOR expression [2 pts.].

   (h) Provide a minimal AND-NOR expression [2 pts.].

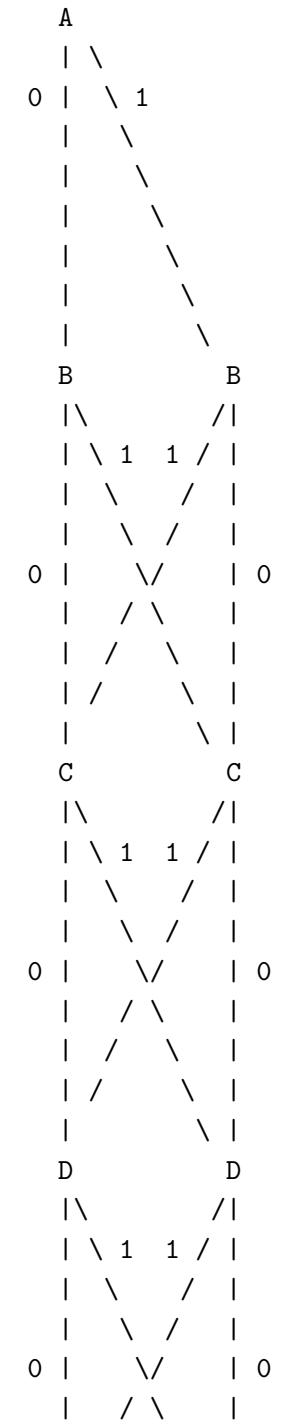
   (i) Provide a minimal NAND-AND expression [2 pts.].

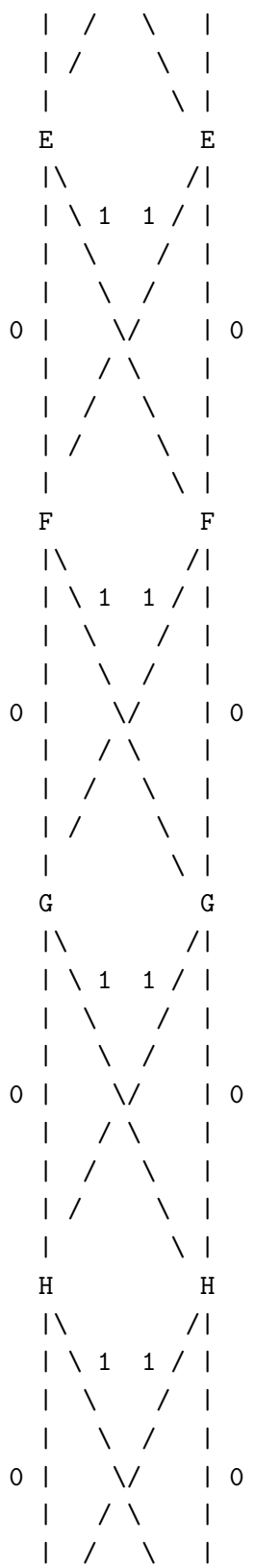
   (j) Provide a AND-XOR expression (with no negations) [10 pts.].

   (k) Draw a reduced Binary Decision diagram for the function [10 pts.].

3. **Expressions from Binary Decision Diagrams** [24 pts.]

   Provide an expression for the function of this BDD.

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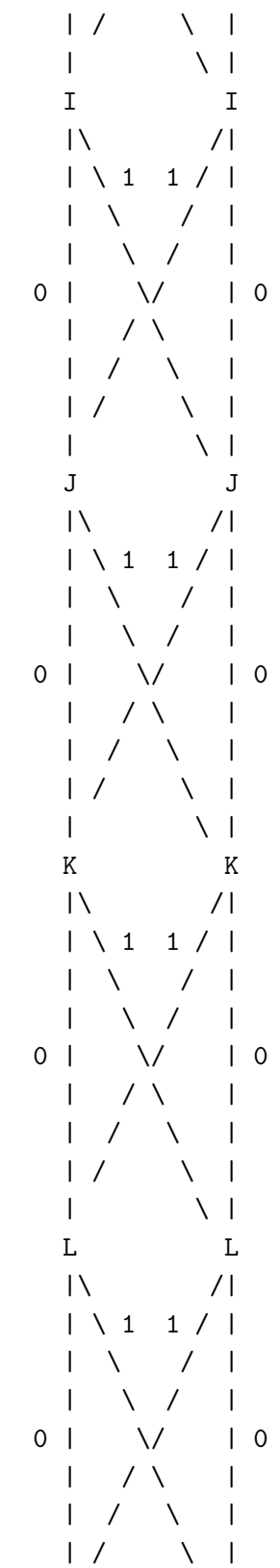
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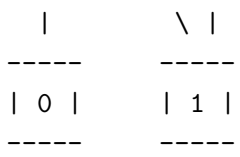
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4. **Timing Analysis** [24 pts.]

   Compute the arrival times at f_1, f_2, and f_3 for each input combination for the following circuit. Assume a delay of 1 for each gate. Assume that the bubbles have *no* delay.

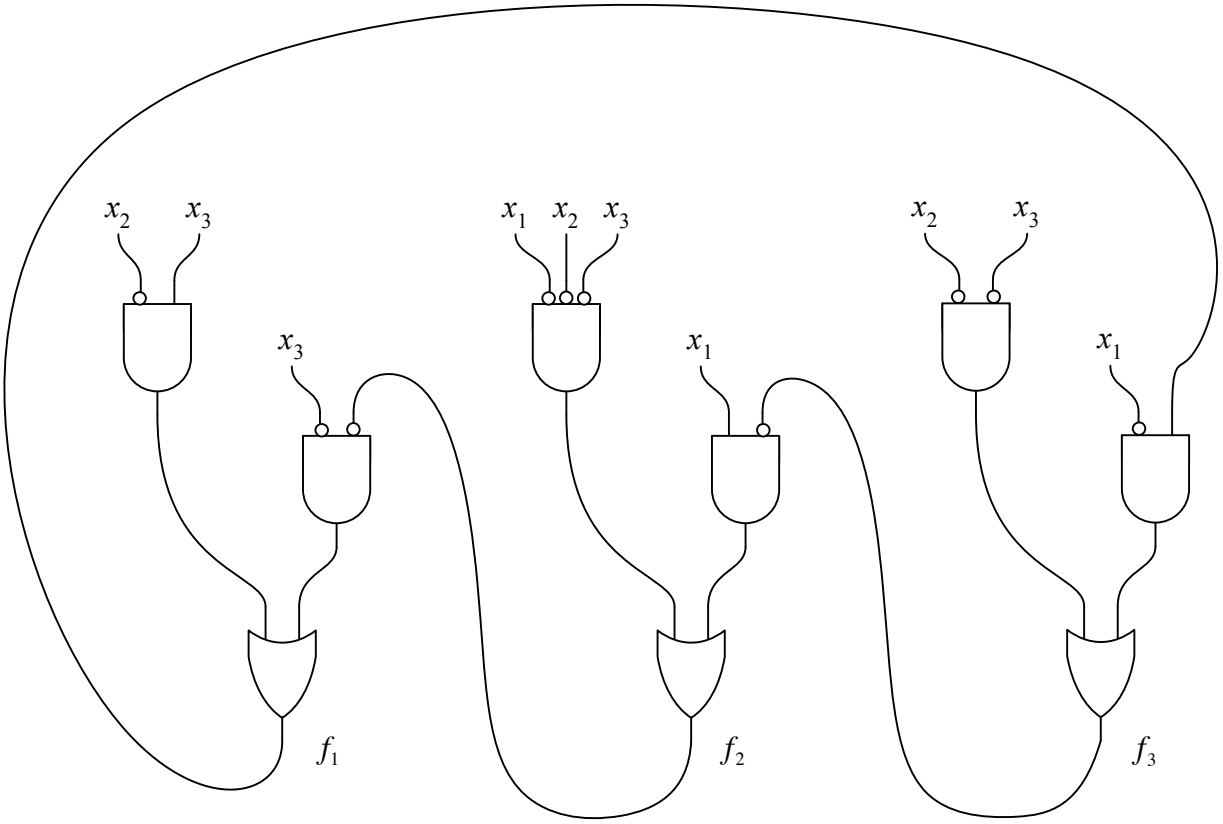

Figure 1: Circuit for Timing Analysis.