EE303 Digital System, Fall 2020
Midterm Exam

October 20th, 2020

1. Design a circuit which will add a 4-bit 2's complement number to a 5-bit 2's complement number. Use full adders. Include a circuit to detect an overflow. [10 pts]

2. If $a'b + ab' = a'c + ac'$, then $b = c$ holds. Prove. [15 pts]

3. The following prime implicant chart is for a four-variable function $f(A, B, C, D)$. [10 pts]
   a. List the maxterms of f.
   b. List the don't-cares of f, if any.

	2	3	7	9	11	13
–0–1		×		×	×	
–01–	×	×			×	
--11		×	×		×	
1--1				×	×	×

4. Given $F_1 = \Pi M(0, 4, 5, 6)$ and $F_2 = \Pi M(0, 4, 7)$, find the maxterm expansion for $F_1 + F_2$.
   State a general rule for finding the maxterm expansion of $F_1 + F_2$, given the maxterm expansion of F_1 and F_2. [15 pts]

5. "If a minterm and all of its adjacent minterms and DCs are covered by a single implicant, then that implicant is essential". Prove. [10 pts]

6. $f(a, b, c, d) = \sum m(1, 3, 5, 6, 8, 9, 12, 14, 15) + \sum d(4,10,13)$. Use the Quine-McCluskey method to find all minimum SOP expressions of f'. [10 pts]

7. $F(A, B, C)$ equals 1 if exactly two of A, B, and C are 1. Find a NOR implementation of F. Use only 2-input NOR gates. [15 pts]

8. Assume a circuit N1 with inputs of a, b, c, d and outputs of p, q, r. Another circuit N2 receives p, q, r as inputs and have two outputs of x and y. Let $p(a, b, c, d) = \Sigma m(1, 5, 11, 13)$, $q(a, b, c, d) = \Sigma m(3, 4, 7, 8, 10, 14, 15)$, and $r(a, b, c, d) = \Sigma m(2, 4, 7, 8, 9, 14)$. Derive a minimum two-level multi-output NAND-NAND network to realize $x(p, q, r) = \Sigma m(1, 4, 5)$ and $y(p, q, r) = \Sigma m(1, 2)$. [15 pts]