

EE 2000 Test 1

ANSWER ALL QUESTIONS

Question 1 (30 marks)

Given the logic functions:

$$(i) F = AB + \bar{B}C\bar{D} + A\bar{B}\bar{D} + AB\bar{C}D + BC\bar{D} + CD$$

$$(ii) G = (A + B + C)(A + B + \bar{C})(A + \bar{B} + C + D)(A + \bar{B} + \bar{C} + D)$$

- (a) plot K-Map for each of the functions, identify the essential prime implicants;
- (b) express (i) in numeric minterm form, *i.e.* $F = \sum m(\dots)$;
- (c) express (i) in minimum product-of-sums form; and
- (d) express (ii) in minimum sum-of-products form;
- (e) implement the result of (c) using 3-input NAND gates only;
- (f) implement the result of (d) using 3-input NOR gates only.

Question 2 (30 marks)

A digital system has three inputs and two outputs with the relation given in the following true table:

Inputs			Outputs	
A	B	C	L_1	L_2
0	0	0	1	1
0	0	1	1	0
0	1	0	0	1
0	1	1	1	0
1	0	0	1	1
1	0	1	0	0
1	1	0	0	1
1	1	1	1	0

- (a) Find L_1 and L_2 in canonical product-of-sums form, simplify the result as far as possible using algebraic manipulation.
- (b) Implement the logic function L_1 and L_2 using AND, OR, and NOT gates.
- (c) Convert (b) into all-NAND circuits. Prove the equivalence of the two circuits using algebraic manipulation. What are the advantages of all-NAND implementation?
- (d) Based on the results of (b), write “Entity” and “Architecture” modules of the system if VHDL implementation is used. Use your first name and last name as the entity and architecture names, respectively.

Question 3 (40 marks)

Abby, Ben, Candy, and Derek get together once a week to either go to a movie or go bowling. To decide what to do, they vote and a simple majority wins. If the number of votes for the two activities is equal, then they have to follow Abby's will. Assuming a vote for the movie is represented by "1" and bowling by "0".

- (a) Give the true table for the decision logic.
- (b) Design a circuit with minimum number of NAND gates that automatically computes the decision.
- (c) Implement the logic function using a 4-to-16-line decoder and minimum number of external gates.
- (d) Implement the logic function using a 3-to-8-line decoder and minimum number of external gates.
- (e) Comment on the cons and pros of the implementations given in (b), (c) and (d).