ELECTRICAL AND ELECTRONICS ENGINEERING
&
COMPUTER ENGINEERING

EEE 248 | CNG 232
Logic Design

21 | SPRING | 22

HW I
Number of Questions: 4

Due: APRIL 11, 2022
Good Luck

Dr. Gürtaç Yemişcioğlu

Student Number:

Full Name:

Question	Achieved	Points
1		8
2		8
3		22
4		28
5		34
TOTAL		100

Question 1 (8 pts.): Perform the following base conversions of unsigned numbers, rounding fractional parts to 2 digits.

a. $(38.45)_{10} = (\ )_2$

b. $(10110.010)_2 = (\ )_{10}$

c. $(723.52)_8 = (\ )_{16}$

d. $(8EA3.4F)_{16} = (\ )_2$

Question 2 (8 pts.): Perform the following (unsigned) operations in binary number system.

a. 1001.01 x 11.11

b. 0111.10 / 10.11

Question 3 (22 pts.):

a. (14 pts.) Convert the +29 and +41 to binary using the signed 2's complement representation and enough digits to accommodate numbers. Then perform the binary equivalent of. Show all your calculations.

i. (4 pts.) (+29) + (-41)

ii. (4 pts.) (-29) + (+41)

iii. (4 pts.) (-29) + (-41)

b. (8 pts.) Perform BCD addition of signed 347 + (- 192). Show your calculations both in binary and decimal.

Question 4 (28 pts.):

a. (12 pts.) Use algebraic manipulation and simplify the following Boolean expressions to a minimum number of literals:

- **i.** (2 pts.) F = a'+ ab + ac' + abc'
- **ii.** (2 pts.) F = x'+ xyz + x (y⊕z) + xy'z'
- **iii.** (2 pts.) F = ab'c + a'b'c + abc
- **iv.** (2 pts.) F = (a + bc' + cd) (b' + ef)
- **v.** (4 pts.) F (a,b,c) = Π (1, 3, 6, 7)

b. (16 pts.) Given Boolean functions:
F(x,y,z)= Σ m (1, 2, 3, 6, 7), G(x,y,z)= Π M (0, 1, 3, 4, 6), H(x,y,z)= F XOR G;

- **i.** (6 pts.) Develop the Truth Table for the three functions (on the same table).
- **ii.** (6 pts.) Use algebraic manipulation and express the function F as an expanded maxterms using product of sums, and function G as an expanded minterms using sum of products (do not use shorthand notation but write down all products and sums openly).
- **iii.** (4 pts.) Implement the function H using a 2-level OR-AND circuit (show logic schematic). Assume inverters are available.

[(A OR B) AND (A NAND B)]

Question 5 (34 pts.):

a. (18 pts.) Given the Boolean function
F(A, B, C, D) = Σ (0, 1, 2, 3, 4, 5, 7, 8, 10, 12, 14)

- **i.** (6 pts.) Draw a Karnaugh Map.
- **ii.** (2 pts.) Identify the prime implicants of F.
- **iii.** (2 pts.) Identify all Essential Prime Implicants of F.
- **iv.** (2 pts.) Derive minimal SOP expressions for F.
- **v.** (2 pts.) Derive minimal POS expressions for F.
- **vi.** (4 pts.) Assume each inverter has a cost of 1, each 2-input NAND gate has a cost of 2, and 4-input NAND gate has a cost of 4. Derive a solution using NAND gates and inverters by minimizing the overall cost. What is the cost of your solution?

b. (16 pts.) Given the Boolean function F(A,B,C,D) = ∑(0,1,6,7,10,11) together with the don't care conditions d(A,B,C,D) = A ⊕ B ⊕ C

- **i.** (4 pts.) Simplify F in sum of products (SOP).
- **ii.** (4 pts.) Implement F with one NAND gate only.
- **iii.** (4 pts.) Simplify F in product of sums (POS).
- **iv.** (4 pts.) Implement F with two NOR gates only.