Homework

1. The homework has three parts. Each part has a different deadline.
2. Submit the homework to Engr. Sidra Gul on or before the deadline. There is a 20% penalty per day for late submission.
3. Copied assignments will be awarded ZERO marks.

Part 1

Due: September 30, 2015

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1. (Reading)

Read Chapter 1, 2, and 3 of the Text Book (Mano's Digital Logic & Computer Design).

2.

Think of ten (10) 3-variables functions and design circuits for them using sum of minterms technique.

3.

Think of five (05) 4-variables functions and design circuits for them using product of maxterms technique.

Part 2

Due: October 09, 2015

1.

Convert $(1278.875)_{10}$ to its equivalent representation in the following bases:

- ➔ Base 16 __________________________
- ➔ Base 8 __________________________
- ➔ Base 2 __________________________
- ➔ Base 7 __________________________
- ➔ Base 3 __________________________

2.

Find the Base 10 equivalents of the following numbers:

- ➔ $(3F1B.25)_{16}$ __________________________
- ➔ $(456723.75)_{8}$ __________________________
- ➔ $(1011110001110101.10011)_{2}$ _________
- ➔ $(31242.2314)_{5}$ __________________________
- ➔ $(31242.60)_{7}$ __________________________

3.

Convert the following numbers directly to binary without using an intermediary base:

- ➔ $(3E89.AC27)_{16}$ __________________________
- ➔ $(22144.3561)_{8}$ __________________________

4.

Convert $(1100110111001010.1011101)_2$ to:

- ➔ Octal ______________________________
- ➔ Hexadecimal ____________________________

Don't use an intermediary base.

5.

Complete the following tables:

Integer conversions between binary, octal, hex, decimal

Original Base	Number to convert	Base to convert to			
		Binary	Octal	Hex	Decimal
Binary	110110				
Octal	123				
Hex	2D				
Decimal	123				

Conversions with fractions (max 3 places of precision)

Original Base	Number to convert	Base to convert to			
		Binary	Octal	Hex	Decimal
Binary	1011.11				
Octal	12.5				
Hex	D.8				
Decimal	7.6				

6.

Convert the following binary numbers to their ones and twos complements:

	Binary Number	1's Complement	2's Complement
a.	110011110001	____________________	____________________
b.	111111111111	____________________	____________________
c.	100000000001	____________________	____________________

Part 3
Due: October 23, 2015

1.

a. Write the first 20 decimal digits in base 2 (binary).
b. Convert the decimal number 250.5 to base 3, base 4, base 7, base 8, and base 16.
c. Convert the following decimal numbers to binary: 12.0625, 104, 673.23, and 1998.
d. Convert the following binary numbers to decimal: 10.10001, 101110.0101, 1110101.110, and 1101101.111.
e. Convert the following numbers from the given base to the bases indicated:
   i. decimal 225.225 to binary, octal, and hexadecimal
   ii. binary 11010111.110 to decimal, octal, and hexadecimal
   iii. octal 623.77 to decimal, binary, and hexadecimal
   iv. hexadecimal 2AC5.D to decimal, octal, and binary
f. Convert the following numbers to decimal:
   i. $(1001001.011)_2$
   ii. $(12121)_3$
   iii. $(1023.2)_4$
   iv. $(4310)_5$
   v. $(0.342)_6$
   vi. $(50)_7$
   vii. $(8.3)_9$
   viii. $(198)_{12}$
g. Obtain the 1´s and 2´s complement of the following binary numbers: 1010101, 0111000, 0000001, 10000, and 00000.
h. Obtain the 9´s and 10´s complement of the following decimal numbers: 13579, 09900, 90090, 10000, and 00000.
i. Find the 10´s complement of $(935)_{11}$.
j. Perform the subtraction with the following decimal numbers using (1) 10´s complement and (2) 9´s complement. Verify the answer by straight subtraction.
   i. 5250 – 321
   ii. 3570 – 2100
   iii. 753 – 684
   iv. 20 – 1000
k. Perform the subtraction with the following binary numbers using (1) 2´s complement and (2) 1´s complement. Verify the answer by straight subtraction.
   i. 11010 – 1101
   ii. 11010 – 10000
   iii. 10010 – 10011
   iv. 100 – 110000

2.

Simplify the following Boolean functions to a minimum number of literals using Iterative technique/Boolean algebra.

a. $A'BC + AC' + BC'$
b. $(A + C)(A' + B)$
c. $[(AB)' + A' + AB]'$
d. $[(AB' + ABC)' + A(B + AB')]'$
e. $AB + (AC)' + AB'C(AB + C)$
f. $A'B'CD + A'BCD + AB'C'D$
g. $A'B'C' + A'B'C + A'BC + ABC$
h. $A'B'C' + A'B'C + A'BC' + AB'C' + AB'C$
i. $xy + xy'$
j. $(x+y)(x+y')$
k. $xyz + x'y + xyz'$
l. $zx + zx'y$
m. $(A + B)'(A' + B')'$
n. $y(wz' + wz) + xy$
o. $ABC + A'B'C + A'BC + ABC' + A'B'C'$
p. $BC + AC' + AB + BCD$
q. $[(CD)' + A]' + A + CD + AB$
r. $(A + C + D)(A + C + D')(A + C' + D)(A + B')$

3.

Obtain the Truth Table/Function Table of the following functions and express each function in sum-of-minterms and product-of-maxterms.

a. $F(x, y, z) = (xy + z)(y + xz)$

b. $F(A, B, C, D) = (A' + B)(B' + C)$

c. $F(x, y, z) = xy + xy' + y'z$

4.

Convert the following to the other canonical form.

a. $F(x, y, z) = \Sigma_m (1, 3, 7)$

b. $F(A, B, C, D) = \Sigma_m (0, 2, 6, 11, 13, 14)$

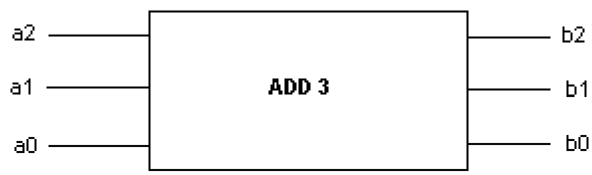
c. $F(x, y, z) = \Pi_M (0, 3, 6, 7)$

d. $F(A, B, C, D) = \Pi_M (0, 1, 2, 3, 4, 6, 12)$

5.
Express the following functions in a sum-of-minterms and a product-of-maxterms.

a. $F(w, x, y, z) = y'z + wxy' + wxz' + w'x'z$
b. $F(A, B, C, D) = (A + B' + C)(A + B')(A + C' + D')(A' + B + C + D')(B + C')$
c. $F(x, y, z) = (xy + z)(y + xz)$

6.
The ´**ADD 3**´ block takes a 3-bit input and gives a 3-bit output. The value at the output is greater than the input by 3. If the output is too big to be represented then all the output bits are set to 1.



a. Construct the Truth/Function Table for the above block.
b. Simplify b_0, b_1, and b_2 using K-Map.
c. Draw the circuit diagram for the above block using AND, OR, and NOT gates.

7.
The ´**MAJORITY GATE**´ block takes a 3-bit input and produces a 1-bit output. The value at the output is equal to 1 if the majority of the inputs are 1´s. The output is 0 otherwise.

a. Build the Truth/Function Table for the above block.
b. Simplify out using K-Map.
c. Draw the circuit diagram for the above block using NAND gates only.

8.
There is a committee with three people. Each person votes either YES or NO for a proposal. If at least two people vote YES, the proposal is passed. Design a circuit that determines whether a proposal passes.

9.
Sometimes the lights are controlled by more than one switch, like in the stairs. The downstairs switch is variable x, and the upstairs switch is the variable y. The lights should get ON when both x and y are ON or both are OFF. Draw the logic circuit of Light (x, y).

10.
Design a logic circuit that accepts a 3-bit number and generates an output binary number equal to the square of the input number.

11.
Design a circuit that compares two 2-bit numbers, A and B, to check if they are equal. The circuit has one output x, so that $x = 1$ if $A = B$, and $x = 0$ if $A \neq B$.

12.
Design a combinational circuit whose input is a 4-bit number and whose output is the 2´s complement of the input number.

13.
You as a System Engineer is given a project to construct a security system for a sensitive military zone. The conditions are as follows:

a. If it is night & door is opened or laser light is disturbed, alarm should go on.
b. In day time military is on duty, so there is no risk.

Develop the logic circuit to meet the above requirements.

14.
Design a logic circuit to produce a HIGH output only if the input, represented by a 4-bit binary number, is greater than twelve or less than three. First develop the truth table and then draw the logic diagram.

15.
Construct the logic circuit to meet the following requirements:
A battery-powered lamp in a room is to be operated from two switches, one at the back door and one at the front door. The lamp is to be ON if the front switch is ON and the back switch is OFF, or if the front switch is OFF and the back switch is ON. The lamp is to be OFF if both switches are OFF or if both switches are ON. Let a HIGH output represents the ON condition and a LOW output represents the OFF condition.

16.
Design a logic circuit that produces a 1 only when the number of 1´s in a set of three input variables A, B, and C is even (i.e. an even parity checker).

17.

Obtain the simplified expressions in sum-of-products for the following Boolean functions:

a. $F(x, y, z) = \sum_m (2, 3, 6, 7)$
b. $F(A, B, C, D) = \sum_m (7, 13, 14, 15)$
c. $F(A, B, C, D) = \sum_m (4, 6, 7, 15)$
d. $F(w, x, y, z) = \sum_m (2, 3, 12, 13, 14, 15)$
e. $F(x, y, z) = xy + x'y'z' + x'yz'$
f. $F(A, B, C) = A'B + BC' + B'C'$
g. $F(a, b, c) = a'b' + bc + a'bc'$
h. $F(x, y, z) = xy'z + xyz' + x'yz + xyz$

18.

Obtain the simplified expressions in product-of-sums for the following Boolean functions:

a. $F(x, y, z) = \prod_M (0, 1, 4, 5)$
b. $F(A, B, C, D) = \prod_M (0, 1, 2, 3, 4, 10, 11)$
c. $F(w, x, y, z) = \prod_M (1, 3, 5, 7, 13, 15)$

19.

Obtain the simplified expressions in (1) sum-of-products and (2) product-of-sums:

a. $F(x, y, z) = x'z' + y'z' + yz' + xyz$
b. $F(A, B, C, D) = (A + B' + D)(A' + B + D)(C + D)(C' + D')$
c. $F(A, B, C, D) = (A' + B' + D')(A + B' + C')(A' + B + D')(B + C' + D')$
d. $F(A, B, C, D) = (A' + B' + D)(A' + D')(A + B + D')(A + B' + C + D)$
e. $F(v, w, x, y) = w'y + vw' + vw'x + v'w + v'w'y'$

20.

Simplify the Boolean function F using the don´t-care conditions d, in (1) sum-of-products and (2) product-of-sums:

a. $F(A, B, C, D) = A'B'D' + A'CD + A'BC$
   $d = A'BC'D + ACD + AB'D'$
b. $F(w, x, y, z) = w'(x'y + x'y' + xyz) + x'z'(y + w)$
   $d = w'x(y'z + yz') + wyz$
c. $F(A, B, C, D) = B'C'D' + BCD' + ABCD'$
   $d = B'CD' + A'BC'D$
d. $F(x, y, z) = y' + x'z'$
   $d = yz + xy$