CS240
Lecturer: Simina Fluture, PhD.

CS240 – Homework 2

For full credit, justify (explain) your answers; <u>show all the work; be detailed in your solution, don't just give the final answer.</u>

In preparing for the exam, each of you should try to solve these problems. However, I need you to create groups of 4-5 students and submit <u>one solution for the entire group</u>.

The solution can be typed or handwritten (readable) and scanned afterwards (into one pdf file). I will create an additional homework column on Blackboard named Homework2.

PROBLEM 1 (give a brief explanation) 15 points

a. What is the range of unsigned integer numbers that can be represented with
4 bits
8 bits
32 bits
n bits

b. What is the range of numbers in signed magnitude format that can be represented with
4 bits
8 bits
32 bits
n bits

c. What is the range of integers in signed 2's complement that can be represented with
4 bits
8 bits
32 bits
n bits

d. What is the range of decimal floating point numbers (IEEE 754 representation) that can be represented with
32 bits
64 bits

e. Explain why the bias for the exponent in the IEEE754 has the value: $2^{k-1} - 1$?

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PROBLEM 2 (30 points)

A. Convert the following (unsigned) decimal numbers to the indicated bases:
Note: if the fraction has very many or infinitely many digits truncated to 3 digits after the point

21.175	to binary
51.750	to octal
33.125	to hexa
18.7	to binary
255	to binary, octal, and hexadecimal

B. Convert the following (**unsigned**) binary numbers to:

- Octal
- Hexadecimal

$1011\ 1011\ 0101\ 1101\ 1101\ 0101\ 1011.11_2$
$1110\ 1111\ 1001\ 1101\ 1011.010011_2$

C. Convert the hexadecimal number D4C39B to binary and octal.

PROBLEM 3 (9 points)

Perform the arithmetic operations (-32) + (11), (+85) + (69) and (-9) + (-12), in binary using the signed 2's complement representation. Use 8 bits registers.

PROBLEM 4 (10 points)

Use Booth's multiplication algorithm for computing:
(-4) x (9)   (-6) x (12)
NOTE: YOU CANNOT SWITCH THE ORDER BETWEEN M AND Q (THE ORDER IS MXQ)

PROBLEM 5 (12 points)

Convert +17.50 in a IEEE 754 single precision format.
Convert - 41.250 in a IEEE 754 double precision format.

PROBLEM 6 (6 points)

What is the decimal floating number represented by the 32-bit word
1000 1110 1110 0000 0000 0000 0000 0000

PROBLEM 7 (12 points) Explain your answer; don't just give the final value. For the first 3 subpoints have it as sum of powers of 2.

Give the decimal number represented by the 32-bit word 1101 0110 1011 0000 0000 0000 0000 0000 if

a. An unsigned representation has been used
b. A sign magnitude representation has been used
c. A signed 2's complement representation has been used
d. A 754 IEEE representation has been used

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PART 2
The following are other problems similar to the ones in the midterm. You might not have yet the theoretical background to solve them right away but you will have it soon.
I will NOT grade them and I do not need a submission for them BUT is useful in preparing you for the midterm

Problem 8: Given the following Boolean function: F = A'C + A'B + AB'C + BC
Express it as sum of minterms

Problem 9:
Show that the dual of the exclusive-OR is equal to its complement.

Problem 10:
Simplify the Boolean expressions using three-variables and four-variables maps: a. F(x,y,z) = ∑(0,2,3,4,7)

b. F(A,B,C,D) = AB'C + B'C'D' + BCD + ACD' + A'B'C + A'BC'D
c. F(x,y,z,w) = ∑(2,3,9,10,12,13,14,15)

Problem 11:
Design a combinational circuit with 3 inputs xyz and three outputs ABC. When the binary input value is 0,1,2,3 the binary output value is one greater than the input. When the binary input is 4,5,6,7 the binary output is two less than the input.

Problem 12:
Implement F(A,B,C) using a multiplexer.
F(A,B,C) = ∑(0,1,5,7)

Problem 13: (from last semester midterm)
A(x,y,z) = ∑(2,3,4,5,6)
B(x,y,z) = x'y'z' + xy' + x'yz'
C(x,y,z) = xy'z' + x'y + xyz'

a. Tabulate the truth table for a ROM that implements the 3 Boolean functions A,B,C. **Draw the circuit.** Specify the **size of the ROM**.

b. **Draw the PLA circuit** that will implement A,B,C
Minimize the number of product terms. **Simplify** the functions.
<u>You don't need to give the PLA table.</u>

c. Implement B(x,y,z) using a **multiplexer**.