Student Id: Name: Signature:

CSE 221 - Principles of Logic Design - 2021 Fall
Homework1

You will use a **"key"** to solve the problems in this homework. The key is the number formed by the last two digits of your student id. **If your key is less than 20, add 20 to it!** (*So for example, if your student id was 20100702047 your key would be "**47**"; if your student id was 20100702008 your key would be "**28**".*) *We will assume that the key is 47* while explaining the problems (you should replace it with your own key).

So, first write down your id and key: **Student Id: . . . . . Key: . . . . . .**

1) m = 3*key (*m=3*47=141*). Find your m. **m = 3 * . . . . . = ...**
Convert m to binary. (*141 = $(10001101)_2$*)

2) m = key/100 (*m=47/100=0.47*). Find your m. **m = ... / 100 = ...**
Convert m to binary (Four digits on the right of the radix point are enough). (*0.47 = $(0.0111)_2$*)

3) m = key mod 30 (*m=47 mod 30=17*). n = (2*key) mod 30 (*n=94 mod 30=4*).
Find your m. **m = ... mod 30 = ...**
Find your n. **n = (. . . . . * 2) mod 30 = ... mod 30 = ...**
if m == 0 $\Rightarrow$ m=5; if n == 0 $\Rightarrow$ n=10
Find the binary equivalents of m and n (m_2 and n_2 respectively) in 6-bits (Do not show the conversion here, do it elsewhere).
(*m=17 then m_2=010001, n=4 then n_2=000100*)

Perform subtraction on unsigned binary numbers m_2 and n_2 using the 2's complement of the subtrahend. If the result is negative, find the 2's complement and affix a minus sign.

p = 3*m mod 40 (*p=51 mod 40=21*). r = 4*n mod 50 (*n=16 mod 50=16*).
Find your p. **p = ... mod 40 = ...**
Find your r. **r = ... mod 50 = ...**
if p == 0 $\Rightarrow$ p=15; if r == 0 $\Rightarrow$ r=25
Find the binary equivalents of p and r (p_2 and r_2 respectively) in 7-bits.
(*p=21 then p_2=0010101, r=16 then r_2=0010000*)

Perform subtraction on unsigned binary numbers p_2 and r_2 using the 2's complement of the subtrahend. If the result is negative, find the 2's complement and affix a minus sign.

4) Use m and n of question 3. (*m=17, n=4*) s=-n. (*s=-4*)
Write down your m, n and s; **m = ... n = ... s = ...**
Now you will write m and s in binary in **signed 2's complement representation**. First you should find the minimum number of bits you should use to represent both of these numbers. (*With 5 digits, the numbers we can represent are between -16 and +15, but m=17 is outside this range; so I have to use at least 6 digits. With 6-bits I can represent numbers from -32 to +31; so m=010001, s=the complement of 000100=111100*)

With . . . . digits, we can represent numbers from . . . . . to . . . . . but . . . . . is outside this range; so I should use . . . . digits. With these . . . . digits, we can represent numbers from . . . . . to . . . . ..

So, **m =** . . . . . and
s = the complement of . . . . . = ...

Find **m + s** in binary. Convert the result to the decimal system (if the result is negative, you should again convert it to decimal). (*010001 + 111100 = 001101 which is equal to 13; which is true because (+17) + (-4) = 13.*)

m : . . . . . .

s : . . . . . .
+ _____

. . . . . .

Find **m - s** in binary, by taking the 2's complement of **s** and adding it to **m**. Convert the result to the decimal system (if the result is negative, you should again convert it to decimal). (*010001 - 111100 = 010101 which is equal to 21; which is true because (+17) - (-4) = 21.*)

m : . . . . . .

s : . . . . . .
- _____

. . . . . .

⇒

. . . . . .

. . . . . .
+ _____

. . . . . .

Is there an overflow problem? ☐ Yes ☐ No If yes, increase the number of bits you use and do the subtraction again and verify again in decimal system.

5) m = key mod 15; if m < 7 then add 7 to m. (*m=47 mod 15=2; add 7, them m=9*).
What is the largest binary number that can be expressed with m bits? What are the equivalent decimal and hexadecimal numbers.

6) m = key * 10. (*m=47*10=470*).
Convert m to binary in two ways: (a) convert it directly to binary:

(b) convert first to hexadecimal and then from hexadecimal to binary:

Which method is faster?