Homework Lecture 4

3.1
Show the results of adding the following pairs of five-bit twos complement numbers and indicate whether or not overflow occurs for each case.

```
  1 0 1 1 0
+ 1 0 1 1 1
-----------
```

```
  1 1 1 1 0
+ 1 1 1 0 1
-----------
```

```
  1 1 1 1 1
+ 0 1 1 1 1
-----------
```

3.3
Add the following twos complement and ones complement binary numbers as indicated. For each case, indicate if there is overflow.

```
  1 0 1 1.1 0 1
+ 0 1 1 1.0 1 1
---------------
```

```
  1 0 1 1.1 0 1
+ 0 1 1 1.0 1 1
---------------
```

3.4
Show the process of serial unsigned multiplication for 1010 (multiplicand) and multiplied by 0101 (multiplier).
In the lecture hardware for a sequential unsigned multiplier is given. So for this example the intermediate steps (content of the registers after each step).

Exercise 1
There is not a unique floating point number system. DEC introduced a 32 bit floating point number system with the following properties (base 2):

- Fraction: 23 bits and additional 1 hidden bit. Point is left of hidden bit
- Exponent: 8 bits in excess 128 code

- Sign bit (0 is positive, 1 is negative).
- Number is not normalized if exponent field is filled with zero's. In that case the represented value (independent of sign and fraction field) is zero.
- Rounding style is truncation.

Questions:
For a) until f) the normalized numbers:

a) Max decimal value of the mantissa (M_{max})
b) Min decimal value of the mantissa (M_{min})
c) Max decimal value of the exponent (E_{max})
d) Min decimal value of the exponent (E_{min})
e) Largest positive decimal value that can be representend (V_{max})
f) Smallest positive decimal value that can be represented (V_{min})

g) What is the smallest positive decimal numbers that can be represented? And what is the next positive value that can be exactly represented?
h) What is the representation of $2\ ^{9}/_{16}$?
i) What is the representation of the decimal value 0.2 ?
j) What decimal value is represented with the pattern:
1 00000111 11010000000000000000001

Exercise 2
The IEEE FP standard 754 also defines a "double precision" floating point number system. Properties:

- total number of bits 64
- sign: single bit (left most bit)
- exponent: 11 bits, excess 1023 code, all zero and all one is used for special numbers.
- fraction 52 bits. A hidden bit is used (not included in the 52 bits). Point is right of hidden bit.

Question: the same questions as a) to f) of previous exercise.