Adder Subtractor

Need concept of negative numbers for subtraction

a) Bits have no meaning only interpertation

b) We know 1 interperation, unsigned

c) Let's learn another 2's complement

① Given: A word size of N-bits

② If MSB is 0, then interpert as unsigned (positive)
If MSB is 1, then value is negative.

③ To negate the interperted value of a 2's complement number, flip the bits and add 1.

Ex Given a word size of 4-bits

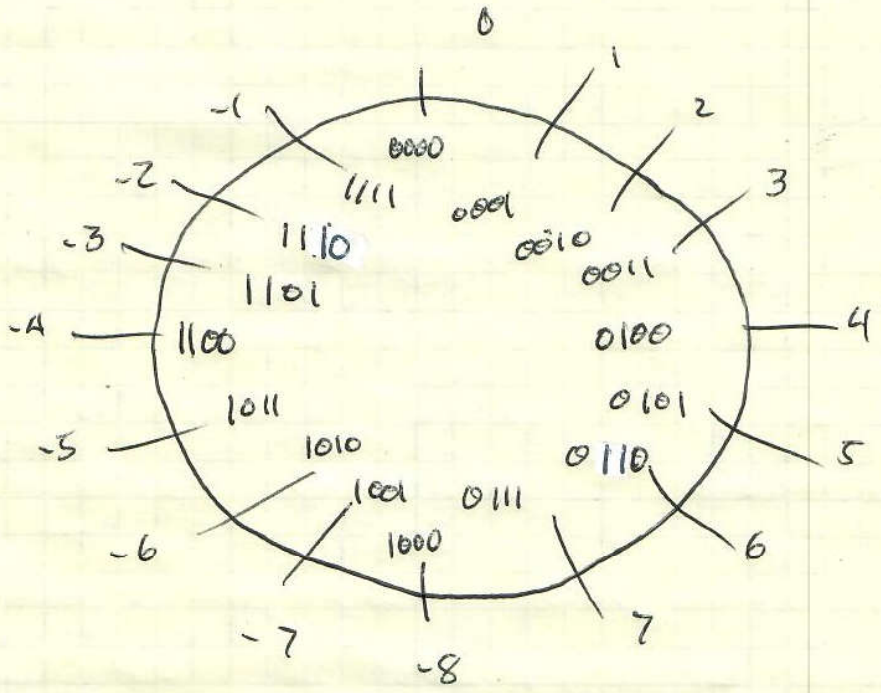
interpert: 0101 as 2's complement 5

1010 as 2's complement

$$1010 = -X = -6$$

$$\begin{array}{r} 0101 \\ +\quad\ 1 \\ \hline 0110 \end{array} = X = 6$$

$$\begin{array}{r} 1001 \\ +\quad 1 \\ \hline 1010 \end{array}$$



range $[2^{N-1}-1 \text{ to } -2^{N-1}]$

Addition & Subtraction

$\begin{array}{r} 6 \\ -7 \end{array} = \begin{array}{r} 6 \\ +(-7) \end{array} = \begin{array}{r} 0110 \\ +1001 \\ \hline 1111 = -1 \end{array} \quad \begin{array}{r} 6 \\ +(-7) \end{array}$ No overflow A

$\begin{array}{r} 3 \\ -2 \end{array} = \begin{array}{r} 3 \\ +(-2) \end{array} = \begin{array}{r} {}^{1}0^{1}0^{1}11 \\ +1110 \\ \hline 0001 \end{array} \quad \begin{array}{r} 3 \\ +(-2) \\ \hline 1 \end{array}$ No overflow B

$\begin{array}{r} 6 \\ +6 \end{array} = \begin{array}{r} {}^{1}0^{1}1^{1}0 \\ 0110 \\ \hline 1100 \end{array} \quad \begin{array}{r} 6 \\ +6 \\ \hline -4 \end{array}$ overflow C

$\begin{array}{r} -6 \\ +0 \end{array} = \begin{array}{r} -6 \\ +(-6) \end{array} \quad \begin{array}{r} {}^{1}{}^{1}0^{1}10 \\ +1010 \\ \hline 0100 \end{array} \quad \begin{array}{r} -6 \\ +(-6) \\ \hline A \end{array}$ overflow D

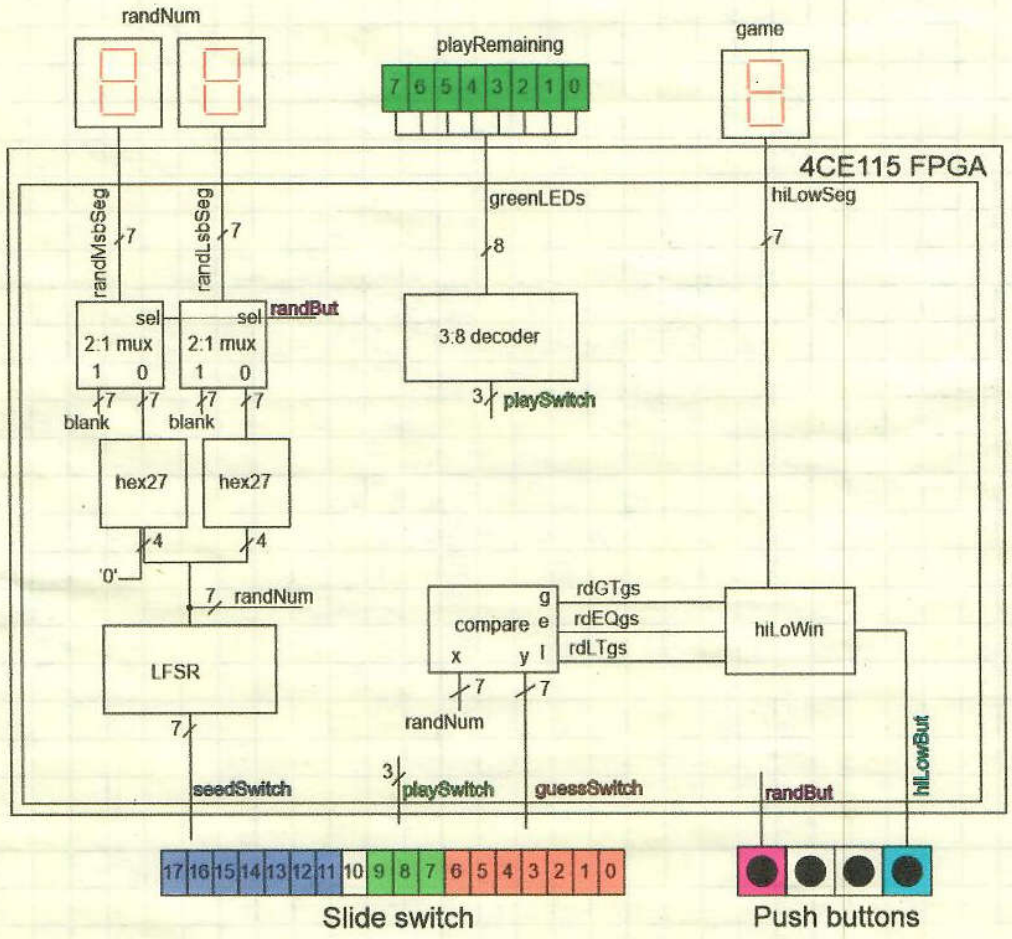
	C_{in}	C_{out}	Ovf
A	0	0	No
D	0	1	Yes
C	1	0	Yes
B	1	1	No

Ovf = 1 when $C_{in} \neq C_{out}$

EEN6 284 | Lab 4

Lab 4- The Guessing game

The guessing game is a two-person game where, one player is the guesser and the other, an honest, secret keeper. The game starts with the secret keeper generating a secret number between [0 and 127], inclusive. Once the secret number is decided, the guesser makes a guess, a number in the interval [0 to 127] inclusive, and tells this to the secret keeper. The secret keep then replies to the guesser if guess is less than, equal to, or greater than the secret number. The game continues with repeated guesser/secret keeper exchange until the guesser correctly identifies the secret number.



Major Points

- Generics
- Mux – provided to you
- Comparator – provided to you
- Decoder – must make using always/case
- LFSR – must make using assign statements
- Testbench – provided to you
- Debugging hints