Tutorial 2
Encoded Integers

Exercise 1

Work out the decimal range of signed and unsigned binary numbers for each of the following word lengths: 4, 8, 16, 32 and *n* bits (for 32 and *n* bits, you can use a power of two notation).

Bits	Unsigned		Signed	
	Min	**Max**	**Min**	**Max**
4				
8				
16				
32				
n				

Exercise 2

Encode the following negative integers into 8-bit signed words: -1, -35, -60, -127, -128.

Exercise 3

For the whole exercise, we use the two's complement encoding (used to encode signed integers).

1. Let us consider the following 8-bit words (in their hexadecimal form): FF, 27, 7E, 9A, B7, 6D, 81. Do they represent positive or negative integers?
2. Write down the range of 8-bit words used to encode positive integers (use the hexadecimal form).
3. Write down the range of 8-bit words used to encode negative integers (use the hexadecimal form).
4. Complete the following table for the addition (write down *Yes* or *No* for the signed overflow).

1st operand	**+**	**2nd operand**	**=**	**Result**	**Signed Overflow**
Positive	+	Positive	=	Positive	
Positive	+	Positive	=	Negative	
Positive	+	Negative	=	Positive	
Positive	+	Negative	=	Negative	
Negative	+	Negative	=	Positive	
Negative	+	Negative	=	Negative	

5. Complete the following table for the subtraction (write down *Yes* or *No* for the signed overflow).

1st operand	-	2nd operand	=	Result	Signed Overflow
Positive	-	Positive	=	Positive	
Positive	-	Positive	=	Negative	
Positive	-	Negative	=	Positive	
Positive	-	Negative	=	Negative	
Negative	-	Positive	=	Positive	
Negative	-	Positive	=	Negative	
Negative	-	Negative	=	Positive	
Negative	-	Negative	=	Negative	

Exercise 4

Perform the following 8-bit binary operations (the two operands and the result are 8 bits wide). Then, convert the result into unsigned and signed decimal values. If an overflow occurs, write down 'ERROR' instead of the decimal value.

Operation	Binary Result	Decimal Value	
		Unsigned	Signed
`11101101 + 11111010`			
`11101000 - 11001010`			
`01011100 - 10011010`			
`01111110 + 00001001`			
`11011011 - 00011010`			
`10000000 + 11110110`			
`10010011 - 00001010`			