[2 marks]

1. A* hexadecimal *number identifies a sequence of bits: $6B_{16}$
Translate the value to decimal, assuming...

$6B_{16} = 0110\ 1011_2$

a) ***an*** 8-bit word, 2's comp

$0110\ 1011_2 = 2^6 + 2^5 + 2^3 + 2^1 + 2^0 = 64 + 32 + 8 + 2 + 1 = \underline{107_{10}}$

b) ***an*** 8-bit word, 2's comp., 3-bit prec.

$0110\ 1.011_2 = 2^3 + 2^2 + 2^0 + 2^{-2} + 2^{-3} = 2^3 + 2^2 + 2^0 + 1/(2^2) + 1(2^3) = 8 + 4 + 1 + 0.25 + 0.125 = \underline{13.375_{10}}$

or $107_{10} / 2^3$ (because of 3-bit prec.) = 107 / 8 = $\underline{13.375_{10}}$

[1 mark]

2. ***Show the* largest positive *and* largest negative *values in fixed-point:*** 8-bit word, 2's comp, 3-bit prec***?***
Answer in decimal.

largest positive: $0111\ 1.111_2 = 15.875_{10}$

largest negative: $1000\ 0.000_2 = -16.0_{10}$

[1 mark]

3. Which part of floating-point ***(FP) is associated with "overflow errors," and which part with "underflow" errors?***

overflow errors indicate an *error in magnitude*, and are associated with the exponent.

underflow errors indicate an *error in precision*, and are associated with the mantissa (significand).

[2 marks]

4. Identify the valid FP representations. Assume a format: 6-bit exponent, 9-bit mantissa***.***

s exp mantissa

a) 1 0 0 0 1 0 1 0 0 0 1 1 1 0 0 0 valid? _NO_

b) 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 valid? _YES_

c) 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 valid? _YES_

d) 1 0 1 1 1 1 1 0 1 1 1 1 1 1 1 1 valid? _NO_

[2 marks]

5. Show the <u>largest</u> and <u>smallest</u> values of the FP format: 6-bit exponent, 9-bit mantissa
<u>Do not translate to decimal</u>.

largest:
x | 0 1 1 1 1 1 | 1 1 1 1 1 1 1 1 1 | most positive exponent, mantissa largest values (all 1's)

smallest:
x | 1 0 0 0 0 0 | 1 0 0 0 0 0 0 0 0 | most negative exponent, mantissa smallest value conforming to the "**.1**" rule

** remember that the sign bit in the representation does <u>not</u> play a role in **range** (magnitude, precision)

[3 marks]

6. Assume the FP format is as above. What value is represented by the 16-bit word?
Answer in <u>decimal</u>

0 0 0 0 1 0 1 1 0 0 1 1 1 0 0 0

1. sign bit: 0 – true value is positive

2. exponent: $000101_2 = 5_{10}$

3. mantissa: .100111000 => normalised value being stored: $.100111_2 * 2^5$

4. true value => $10011.1_2 = 2^4 + 2^1 + 2^0 + 2^{-1} = 16 + 2 + 1 + .5 = 19.5_{10}$