May 2020 Past paper:

3. (a) The Brookshear floating point representation for a binary fraction x consists of eight bits, labeled **s**, **e1**, **e2**, **e3**, **m1**, **m2**, **m3**, **m4** from left to right. If x is zero, then all eight bits are zero. If x is strictly negative, then the sign bit s is 1. If x is strictly positive, then the bit s is zero. Next, suppose x is not zero. To obtain the remaining seven bits, x is written in the form:

$$\pm 2^r * 0.t$$

where r is an integer and t is a bit string such that the leftmost bit of t is 1. The bits e1, e2, e3 together comprise the three bit excess notation for r and the bits m1, m2, m3, m4 of the mantissa are the leftmost four bits of t.

Obtain the decimal fraction with the Brookshear representation 10101100. Show the sign, the mantissa and the decimal representation of the exponent r. Describe explicitly the way in which the answers are obtained. (7 marks)

(b) Find an 8-bit string which is not the Brookshear representation for any number. Justify your answer.

Solution a:

Separate the bits, according to their significance:

10101100

Sign bit: 1, therefore this is a negative number

r bits: 0b010.
(see also tutorial notes on excess notation from week 4)
Three bits are used in excess notation form, therefore, 100 represents 0, 111 represents 3 and 000 represents -4.

In this case, the binary number is: 010, representing -2

Mantissa bits: 1100
We are told that m1,m2,m3,m4 represent t and that the value of the mantissa is 0.t.
We see that the mantissa bits are: 0b1100, representing 0d12
Therefore, the mantissa is: 0.12

Therefore, the number represented is: $-2^{-2} * 0.12$

Solution b:
The bit string: **1 000 0000** is not the Brookshear representation of any number because its sign bit is set, indicating a negative number. At the same time, the remaining seven bits evaluate to 0 ($2^{-4} * 0.0 = 0$). At the same time, we are told that if the represented number is 0, then all eight bits must be equal to 0. Therefore, the above mentioned bit string does not represent a Brookshear floating point number.