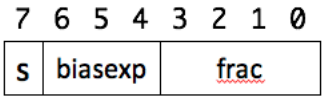
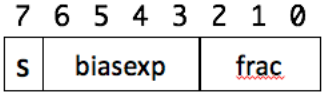
Question 2 (10 points):

(A)



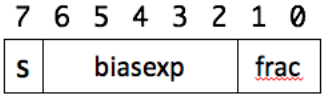
$$N = \begin{cases} (-1)^S \times 0.\text{fraction} \times 2^{-2} & \text{if biasexp} = 0 \\ (-1)^S \times 1.\text{fraction} \times 2^{\text{biasexp}-3} & \text{if } 0 < \text{biasexp} \leq 7 \end{cases}$$

(B)



$$N = \begin{cases} (-1)^S \times 0.\text{fraction} \times 2^{-6} & \text{if biasexp} = 0 \\ (-1)^S \times 1.\text{fraction} \times 2^{\text{biasexp}-7} & \text{if } 0 < \text{biasexp} \leq 15 \end{cases}$$

(C)



$$N = \begin{cases} (-1)^S \times 0.\text{fraction} \times 2^{-14} & \text{if biasexp} = 0 \\ (-1)^S \times 1.\text{fraction} \times 2^{\text{biasexp}-15} & \text{if } 0 < \text{biasexp} \leq 31 \end{cases}$$

Figure 1: Three alternative formats for 8-bit floating-point representation.

Recently Microsoft announced that they are now using an 8-bit floating-point representation for their Field-Programmable Gate Array (FGPA) hardware to support deep neural networks. However, they have not disclosed the specifics of this format. Figure **??** shows three possibilities for the definition of and FP8 format. All these formats assume that there is no need for special value representations such as NaN and $\pm\infty$.

1. (**4 points**) Which format(s) is(are) suitable if the upper limit of the range of values that must be represented is 448.0_{10}. Explain your answer.

2. (**6 points**) Let $X = 2.25$. What is the binary representation of X in each of the three formats? If the value cannot be represented in the format, represent the closest value, rounding to the nearest even, and indicate that it is an approximation.

   (a) format A:

   (b) format B:

   (c) format C: