CS2100 Tutorial 1
AY 24/25 Sem 1 — github/omgeta

Q1. 1. Suppose $x = msb(x) << (n-1) + r$ is the n-bit number to be extended to m-bit number y
2. Case 1 $(msb(x) = 0)$: left padding by zero has no effect so $y = x$
3. Case 2 $(msb(x) = 1)$:
    3.1. $y = 1_1 \cdots 1_{m-n+1} << (n-1) + r$, i.e. sign extension adds $m-n$ leading ones
    3.2. $y = -2^{m-1} + 2^{m-2} + \cdots + 2^{n-1} + r$
    3.3. $y = -2^{m-1} + 2^{n-1}(2^{m-n} - 1) + r$ (Geometric progression)
    3.4. $y = -2^{m-1} + 2^{m-1} - 2^{n-1} + r = -2^{n-1} + r$
    3.5. $\therefore y = 1 << (n-1) + r = x$
4. Therefore, in both cases sign extension is value preserving   ■

Q2. Sign extension is used to add left padded zeros for component binaries

    a. $0101.1100 - 0010.0101 = 0101.1100 + 1101.1010 = 0011.0111_{1s}$ ■

    b. $010111.101 - 0111010.11 = 0010111.101 + 1000101.001 = 1011100.110_{1s}$ ■

Q3.   a. $1.75 \xrightarrow{\text{to binary}} 0001.110_{2s}$ ■

    b. $-2.5 \xrightarrow{\text{to binary}} 1101.100_{2s}$ ■

    c. $3.876 \xrightarrow{\text{to binary}} 0011.111_{2s}$ ■

    d. $2.1 \xrightarrow{\text{to binary}} 0010.001_{2s}$ ■

All numbers cannot be represented exactly and most must be approximated. Precision is limited by the number of fractional bits.

Q4. $-0.078125 = -0.000101_2 = -1.01 \times 2^{-4}$
Exponent $= -4 + 127 = 123 = 01111011_2$
Representation $= 1\ 01111011\ 010000\cdots = 1011\ 1101\ 1010\ 0000\cdots = BDA00000$ ■

Q5.
```c
int readArray(int arr[], int limit) {
    int i, input;

    printf("Enter up to %d integers, terminating with
    a negative integer.\n", limit);

    for (i = 0; i < limit; i++) {
      scanf("%d", &input);
      if (input >= 0) arr[i] = input;
      else break;
    }

    return i;
}
```

Q6.
```
// Iterative
void reverseArray(int arr[], int size) {
  for (int i = 0, j = size-1; i < j; i++, j--) {
    int tmp = arr[i];
    arr[i] = arr[j];
    arr[j] = tmp;
  }
}

// Recursive
void reverseArray(int arr[], int size) {
  if (size >= 2) {
    int tmp = arr[0];
    arr[0] = arr[size-1];
    arr[size-1] = tmp;
    reverseArray(arr+1, size-2);
  }
}
```

Q7. a = 55, c = 15, e = 0
    *b = 55, *d = 55, *f = 0   ∎