CS 254: Assignment 7

Devansh Jain	Harshit Varma
190100044	190100055

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Run Length Encoding

Expected Input Format:

```
00000010
<actual input>
00000011
```

`00000010` is the ASCII "start of text" character and `00000011` is the ASCII "end of text" character.

Description of TestBench (File `ASCII_Read_test.vhd`):

The TestBench has a `while true` loop that stops when the input buffer exceeds the declared capacity and throws an error. This error is not a bug, it helps stopping the while loop.
A `while true` loop has been used to ensure that the buffer empties itself after the entire input is read. Each clock cycle, if we have a valid output, we pop the output buffer (using the output pop counter) and return only 1 byte at in a clock cycle.

Description of RLE (File `RLE.vhd`):

We maintain 2 buffers: one for the input stream and one for the output stream.
We use a arrays of 8-bit vectors to implement the buffers. The input buffer is of size 41 and the output buffer is of size 81.
Size of the output buffer is kept at twice the size of the input buffer (which is same as input length) because the worst-case possible input is `c ESC c ESC ...` which would give us twice the number of characters in the output `c ESC 1 ESC c ESC 1 ESC ....`

We maintain 5 integer counters: one that pushes into the input buffer, one that pops from the input buffer, one that pushes into the output buffer, one that pops from the output buffer and one that keeps count of the character frequency. These values are updated appropriately throughout the code.

We handle the cases for $2 < n < 16$, $n = 2$, and $n = 1$ separately. (We reset the counter for n when it exceeds 15)
The case for `ESC` is also handled separately for $n = 2$ and $n = 1$.

BLOCK DIAGRAM

clk — | RLE | — dataline ⎱ if (dataline)
                         ⎰ write to file

if (not eof)
read from ⎰ input —
file   ⎱   — output ⎱

Counters (integers)   Buffers (array of
. input-counter   std-logic-vector)
output-counter
proc-counter
char-counter
out-counter   push (input-counter)
                    pop (proc-counter)   - in-buf
input —   (size = 41)
                                                ∵ character
                                                  count is
                Processing   limited to
                                                   32.
                              push   (as per PS).
                             (out-
                              counter)   out-buf
repetition   (size = 81)
(char-counter)   ∵ worst case
                                                 scenorio
                                                 |out-buf|
                                                 = 2|in-buf|

clk —   — output

                                                 — dataline

                                                 depends on
                                                 out-counter
                                        and   output-counter