Final Exam Exercise

Problem 1

Draw a block diagram of the datapath of a circuit capable of executing the pseudocode given below.
In this code, MEM_D represents a single-port memory of the size of 32 x 16. The circuit takes as an input a stream of 8-bit ASCII characters representing a GMU catalog. It searches for the first 32 instances of the string “GMU”. Then, it calculates an average and maximum distance between the two subsequent repetitions of this string (including the distance between the first instantiation of the string and the beginning of the catalog).

begin:

wait for s=1
done = 0
count = 0
first = SPACE
second = SPACE
third = SPACE
last = 0; sum=0; max=0
i=-2

while (count < 32) do
    first = second
    second = third
    third =din
    if ((first = ‘G’) and (second = ‘M’) and (third = ‘U’)) then
        dist = i - last
        last = i
        sum = sum + dist
        if max < dist then
            max = dist
        end if;
        MEM_D[count] = dist
        count ++;
    end if;
    i++
end while

avr = sum/32

done = 1
wait for s=0
// when s=0, an external circuit can read data from the memory MEM_D, one number at a time,
// using ports mem_addr and mem_dout
go to begin

Please clearly mark the widths of all buses in your circuit.
In the above pseudocode:
SPACE represents an 8-bit ASCII code of the space = 0x20.
The ASCII codes of ‘G’, ‘M’, and ‘U’ are 0x47, 0x4D, and 0x55, respectively.

Assume the following interface to your circuit:

<table>
<thead>
<tr>
<th>Port</th>
<th>Width</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>clk</td>
<td>1</td>
<td>System clock.</td>
</tr>
<tr>
<td>reset</td>
<td>1</td>
<td>System reset – clears all internal registers and counters. Active high.</td>
</tr>
<tr>
<td>din</td>
<td>8</td>
<td>Input data bus.</td>
</tr>
<tr>
<td>s</td>
<td>1</td>
<td>Operating mode: 0 = waiting for data/reading results, 1 = processing.</td>
</tr>
<tr>
<td>rd</td>
<td>1</td>
<td>Read enable. 0 = high impedance on the output bus dout, 1 = valid output dout</td>
</tr>
<tr>
<td>dout</td>
<td>8</td>
<td>One of the two results calculated by the circuit.</td>
</tr>
<tr>
<td>sel_out</td>
<td>1</td>
<td>Selection between the two calculated results: 0 = avr, 1 = max.</td>
</tr>
<tr>
<td>mem_addr</td>
<td>5</td>
<td>Address in memory location MEM_D.</td>
</tr>
<tr>
<td>mem_dout</td>
<td>16</td>
<td>High impedance (if s=1) or value of memory location MEM_D[mem_addr] (if s=0).</td>
</tr>
<tr>
<td>done</td>
<td>1</td>
<td>Asserted when all results are ready, zero otherwise</td>
</tr>
</tbody>
</table>

Problem 2

1. Draw an ASM chart corresponding to the pseudocode from Problem 1.
2. Express all operations in your ASM chart in terms of active values of control signals generated as outputs of the Control unit and used as inputs in the Datapath.