Class Exercise on RTL Design Methodology

Design a circuit capable of executing the pseudocode given below.
In this pseudocode, 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 consecutive repetitions of this string (including the distance between the first instantiation of the string and the beginning of the catalog). Assume that the maximum distance between two consecutive repetitions of the string "GMU" is smaller than 2^{16}.

```
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:

Port	Width	Meaning
clk	1	System clock.
reset	1	System reset. Takes the Controller to the initial state. Active high.
din	8	Input data bus.
s	1	Operating mode: 0 = waiting for data/reading results, 1 = processing.
rd	1	Read enable. 0 = high impedance on the output bus dout, 1 = valid output dout
dout	16	One of the two results calculated by the circuit.
sel_out	1	Selection between the two calculated results: 0 = avr, 1 = max.
mem_addr	5	Address in memory location MEM_D.
mem_dout	16	High impedance (if s=1) or value of memory location MEM_D[mem_addr] (if s=0).
done	1	Asserted when all results are ready, zero otherwise

Task 1

Draw a block diagram of the Datapath for the circuit defined above.

Use only well-known medium complexity combinational and sequential circuit building blocks.

Clearly specify

- names, widths and directions of all buses
- names, widths and directions of all inputs and outputs of the logic components.

Task 2

Draw an interface of this circuit with the division into the Datapath and Controller.

Task 3

A. Draw the first version of an ASM chart describing the Controller of your circuit by using actions and expressions corresponding (as much as practical) to the instructions of the pseudocode.
B. Draw the second version of the same ASM chart, expressing all operations in terms of active values of control signals generated as outputs of the Controller and used as inputs in the Datapath.