

**Final Exam  
Spring 2007  
May 17, 2007  
(25 points)**

**Part II (open books, open notes)  
(1 hr 45 minutes, 5 questions, 3x5+1x2.5 pt, 17.5 points)**

**Problem 1 (5 points)**

Draw a block diagram of the execution unit of a circuit capable of storing 33 8-bit values in an internal memory, and then computing in parallel:

- a. the position of a smallest number in the set
- b. the second smallest number in the set
- c. an average of all numbers except the smallest number in the set.

Assume the following interface to your circuit:

Port	Width	Meaning
clk	1	System clock
reset	1	System reset – clears internal registers
Rdata	8	Data input
Raddr	6	Address to which input data is loaded during initialization
RWrite	1	External write
START	1	Start of computations
DONE	1	Completion of computations
Pos_max_avr	2	Choice between reading the position of the smallest, value of second smallest, and an average of numbers from the set
Rout	8	Result of computations

**Problem 2 (5 points)**

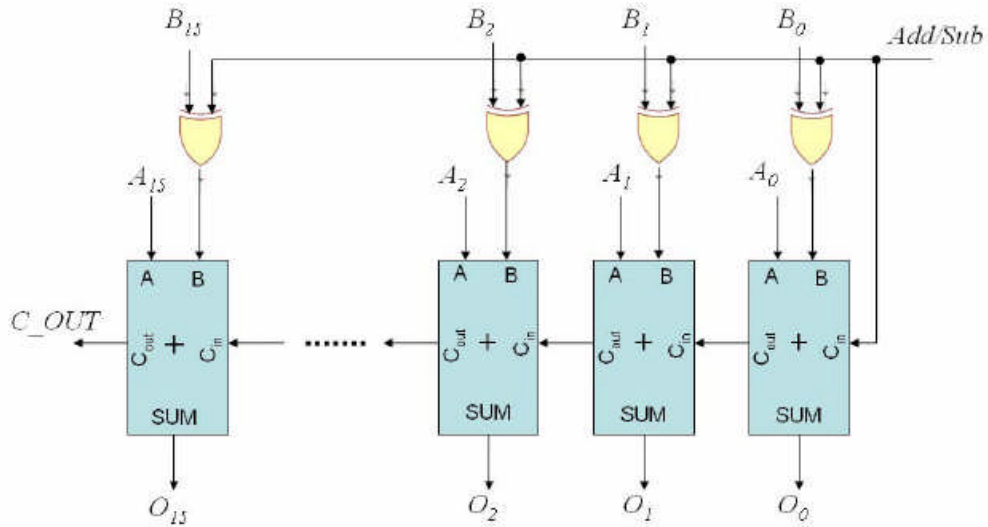
Draw an ASM chart corresponding to the following pseudocode:

```
for (i=0; i<32; i++)
  Memory(i) = Data
for (i=0; i<16; i++)
{
  Tmp1 = Memory(32-i)
  Tmp2 = Memory(i)
  Memory(32-i) = Tmp2
  Memory(i) = Tmp1
}
```

Express all operations in terms of active values of control signals of components involved in these operations.

**Problem 3 (2.5 points)**

Describe the following circuit in VHDL using “for generate” statements. In case you use component instantiations, you need to fully define all components you instantiate.



**Problem 4 (5 points)**

Modify the code of the File I/O testbench provided in your answer sheet, in such a way that it can verify the operation of a multiplier accumulator that computes a sum of 64 products  $X_i \cdot Y_i$ . Assume that each multiplication takes 8 clock cycles to execute, and an addition takes one clock cycle to execute.

Port	Width	Meaning
$X_i$	8	Operand A
$Y_i$	8	Operand B
clk	1	Clock
reset	1	Reset
load	1	Load operands
S	22	Output $C=A \cdot B$

Assume the following format of an input file:

```
load reset X Y
load reset X0 Y0
load reset X1 Y1
.....
load reset X63 Y63
expected_sum
```

Assume that  $X_i$ ,  $Y_i$ , and expected sum S are provided in the hexadecimal notation, and that the first line of the input file is used to reset the internal sum.