

UC Berkeley  
College of Engineering  
EECS Department

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Quiz #7

Name: \_\_\_\_\_

SID: \_\_\_\_\_ Lab section number: \_\_\_\_\_

**NOTE: THIS IS ONE OF YOUR HOMEWORK PROBLEMS**

Consider the design of a new list processor similar to the one presented in class. This circuit iteratively forms the sum of all the 8-bit integers stored in a linked-list structure starting at memory address 0. The integers are stored in 2 byte nodes (the first byte is a pointer to the next node and the second is the integer). Nodes are not restricted to be aligned on even multiples of 2 bytes.

Unlike the processor presented in class, this processor, in addition to forming the sum, stores to memory into each node the sum of all the nodes up to that point. Therefore, after completion, node  $i$  will contain the sum of the values of all the nodes from the first up to and including the  $i$ th. For example, the original list  $1 \rightarrow 2 \rightarrow 3 \rightarrow 4$  will be transformed into  $1 \rightarrow 3 \rightarrow 6 \rightarrow 10$ .

Your circuit includes a memory with an 8-bit data input/output port, a single adder, multiplexors, and registers of your choice.

- a) Draw a resource utilization chart for this list processor. Fill in the execution schedule showing at least three loop iterations. Attempt to create a schedule in such a way as to minimize 1) the total number of cycles needed to process a list, and 2) the number of cycles in the control loop. **Use subscripts to distinguish different loop iterations.**
- b) Based on your solution to a), write the RTL description for one characteristic section of your schedule. **Use subscripts to distinguish operations from different loop operations.**

Memory	X <sub>2</sub>	Next <sub>3</sub>	Write <sub>2</sub>	X <sub>3</sub>	Next <sub>4</sub>	Write <sub>3</sub>	X <sub>4</sub>	Next <sub>5</sub>	Write <sub>4</sub>
		Sum <sub>2</sub>	Numa <sub>3</sub>		Sum <sub>3</sub>	Numa <sub>4</sub>		Sum <sub>4</sub>	Numa <sub>5</sub>

$X_i \leftarrow \text{memory}[\text{numa}_i];$   
 $\text{Next}_{i+1} \leftarrow \text{memory}[\text{next}_i], \text{sum}_i \leftarrow \text{sum}_{i-1} + x_i;$   
 $\text{Memory}[\text{numa}_i] \leftarrow \text{sum}_i, \text{numa}_{i+1} \leftarrow \text{next}_i + 1$