"This exam in 5 pages, make sure to read all the questions and use the backside as a draft area"

1. (15 Points) **True or False? Why?**

a. Nowadays Processors getting faster by increasing the number of cores/transistors.   [   ]

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b. GPU are optimized to decrease latency.   [   ]

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c. An SM can run more than one block at the same time.   [   ]

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d. Accessing Shared memory takes less time compared to accessing local memory.   [   ]

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e. Map pattern represent a many to one relation between the input and the output.   [   ]

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f. Blurring an image is an application example of Gather pattern.   [   ]

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g. Total work complexity can be used alone to measure a parallel program efficiency.   [   ]

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h. Parallel Reduce program has steps complexity = O(logn).   [   ]

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i. The factorial operation is a reduction operator.   [   ]

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j. Blelloch reduce algorithm is the best solution if we have a massive input size.   [   ]

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k. Atomic operations increase the parallel algorithm efficiency.   [   ]

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l. It's not possible to write a parallel solution for the Compact problem .   [   ]

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m. The total work complexity of Merge sore is O(nlogn).   [   ]

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n. Coalesce global memory accesses decrease GPU programming efficiency.   [   ]

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o. GPUs can perform loop instructions better than CPUs.   [   ]

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2. (10 points) **Read the following code snippet then answer the questions:**

```
1   void my_fun(float * d_out, float * d_in, int size){
2
3       for(int i=0;i<size;i++)
4           d_out[i]=d_in[i]*d_in[i];
5   }
```

a. **What is purpose of this program ?**

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b. **What are the steps and total work complexity of this program?**

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c. **Write a CUDA kernel to parallelize this program:**

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d. **What is the steps and total work complexity of your CUDA program?**

Parallel Processing – CSW325
Final Exam, 60 Points

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3. (15 points) **Use the following array to answer the questions: [2, 1, 7, 5, 0, 3, 4, 1, 0, 6]:**

a. **Apply an exclusive max scan on the given array and show every step:**

b. **Given list of segments heads [1, 0, 0, 0, 1, 0, 0, 1, 0, 1]. Apply segmented sum scan (Inclusive) technique:**

c. **Apply the Radix sort, and show every step:**

4. (10 points**) Given the following Matrices multiplication** $\begin{bmatrix} 0 & 1 & 2 \\ 5 & 0 & 3 \\ 0 & 3 & 0 \end{bmatrix} \times \begin{bmatrix} 4 \\ 1 \\ 0 \end{bmatrix}$.

 a. What is the total work to multiply these matrices?
 b. Convert the matrices to CPR format and apply the multiplication (show every step).
 c. What is the total work to multiply these matrices using CPR format ?
 d. Explain how can we program CPR multiplication in parallel?

5. (5 points**) Suppose we have a program with two parts, serial part represents 20% and parallel part represents the 80%. Write the Amdahl's law then Calculate the speed up of this program if you run it on a CPU with 4 thread.**

6. (5 points**) If all operations take exactly 1 second, how long to complete the following:**

```
cudaStream_t s1, s2;

a. cudaMemcpyAsync(&d_arr1, &h_arr1, numbytes, cudaH2D, s1)
   A<<<1, 128, s2 >>>(d_arr2);
```

```
b. cudaMemcpyAsync(&d_arr1, &h_arr1, numbytes, cudaH2D, s1)
   A<<<1, 128, s1 >>>(d_arr1);
```