Assignment 1

Due September 19, 2011

You may type or write your answers by hand. If you write by hand, make sure it is clearly presented. **Do not use pencils but ink**. Please put your name and student ID clearly on the submitted assignment.

You may make use of reasonable assumptions of your own for data that might be missing in the problem texts, provided that they are explicitly and clearly stated.

You may submit a partial answer to a problem. The grading will account for this.

Question 0, Feedback (1 pt extra credit)

How many hours did you spend working on this homework assignment?

Question 1, Yield and Cost (5 pts)

It costs $1 billion to build a new fabrication facility. You will be selling a range of chips from that factory, and you need to decide how much capacity to dedicate to each chip. Your Woods chip will be 150 mm^2 and will make a profit of $20 per defect-free chip. Your Markon chip will be 250 mm^2 and will make a profit of $25 per defect-free chip. Your fabrication facility will be identical to that for the Power5. Each wafer has a 300 mm diameter. Assume $\alpha = 4$.

a. How much profit do you make on each wafer of Woods chip?

b. How much profit do you make on each wafer of Markon chip?

c. Which chip should you produce in this facility?

d. If your demand is 50,000 Woods chips per month and 25,000 Markon chips per month, and your facility can fabricate 150 wafers a month, how many wafers should you make of each chip?

Question 2, Power and Cooling (5 pts)

One critical factor in powering a server farm is cooling. If heat is not removed from the computer efficiently, the fans will blow hot air back onto the computer, not cold air. We will look at how different design decisions affect the necessary cooling, and thus the price, of a system. Use Table 1 for your power calculations.

a. A cooling door for a rack costs $4000 and dissipates 14 KW (into the room; additional cost is required to get it out of the room). How many servers with an Intel Pentium 4 processor, 1 GB 240-pin DRAM, and a single 7200 RPM hard drive can you cool with one cooling door?

Table 1: Power consumption of several computer components.

Component type	Product	Performance	Power
Processor	Sun Niagara 8-core	1.2 GHz	72-79 W
	Intel Pentium 4	2 GHz	48.9-66 W
DRAM	Kingston X64C3AD2 1 GB	184-pin	3.7 W
	Kingston D2N3 1 GB	240-pin	2.3 W
Hard disk	DiamondMax 16	5400 RMP	7.0 W read/seek, 2.9 W idle
	DiamondMax Plus 9	7200 RPM	7.9 W read/seek, 4.0 W idle

b. You are considering providing fault tolerance for your hard drive. RAID 1 doubles the number of disks (see Chapter 6). Now how many systems can you place on a single rack with a single cooler?

c. Typical server farms can dissipate a maximum of 200 W per square foot. Given that a server rack requires 11 square feet (including front and back clearance), how many servers from part (a) can be placed on a single rack, and how many cooling doors are required?

Question 3, Reliability and Availability (5 pts)

In a server farm such as that used by Amazon or the Gap, a single failure does not cause the whole system to crash. Instead, it will reduce the number of requests that can be satisfied at any one time.

Table 2: Statistics on sales for Gap and Amazon. Data compiled from AP [2005], Internet Retailer [2005], Gamasutra [2005], Seattle PI [2005], MSN Money [2005], Gap [2005], and Gap [2006].

Company	Time period	Amount	Type
Gap	3rd qtr 2004	$4 B	Sales
	4th qtr 2004	$4.9 B	Sales
	3rd qtr 2005	$3.9 B	Sales
	4th qtr 2005	$4.8 B	Sales
	3rd qtr 2004	$107 M	Online sales
	3rd qtr 2005	$106 M	Online sales
Amazon	3rd qtr 2005	$1.86 B	Sales
	4th qtr 2005	$2.98 B	Sales
	4th qtr 2005	108 M	Items sold
	Dec 12, 2005	3.6 M	Items sold

a. If a company has 20,000 computers, and it experiences catastrophic failure only if 2/5 of the computers fail, what is the MTTF for the system? Assume each failure is independent, and the lifetimes are exponentially distributed.

b. Given Amazon's highest quarterly income, and assuming that all computers are equally and fully loaded (which is not true), how much money is lost per day to computers failing?

c. If it costs an extra $500 per computer to double the MTTF, would this be a good business decision? Show your work.

Question 4, Amdahl's Law (5 pts)

Your company has just bought a new dual Pentium processor, and you have been tasked with optimizing your software for this processor. You will run two applications on this dual Pentium, but the resource requirements are not equal. The first application needs 75% of the resources, and the other only 25% of the resources.

a. Given that 60% of the first application is parallelizable, how much speedup would you achieve with that application if run in isolation?

b. Given that 95% of the second application is parallelizable, how much speedup would this application observe if run in isolation?

c. Given that 60% of the first application is parallelizable, how much *overall system speedup* would you observe if you parallelized it, but not the second application?

d. How much overall system speedup would you achieve if you parallelized both applications, given the information in parts (a) and (b)?