COMP206 (Fall 2003) **Homework 1** Assigned: September 10, 2003
Prof. Montek Singh Due: September 22, 2003, 2pm

Note: This homework assignment is in two parts, Part I and Part II. Part I consists of problems from the textbook (Hennessy/Patterson 3rd ed., or "HP3") whose solutions appear at the end of the book. These problems are for self-study only, and will not be graded, and therefore should not be submitted as part of your written work. Part II consists of problems that will count towards your grade for this homework.

Part I (not graded):

1. **Amdahl's Law.** Do HP3 Problem 1.4.
2. **Summarizing Performance.** Do HP3 Problem 1.10.
3. **Amdahl's Law.** Do HP3 Problem 1.16.
4. **Native vs. Normalized MFLOPS.** Do HP3 Problem 1.18.

Part II (to be graded):

1. (20 points) **Cost and Performance.** Do HP3 Problem 1.1.
2. (15 points) **Instruction Counts and MIPS.** Do HP3 Problem 1.7.
3. (15 points) **Defect Densities and Chip Costs.** Do HP3 Problem 1.9.
4. (15 points) **Benchmarks and Numerical Coprocessors.** Do HP3 Problem 1.17.
5. (15 points) **Performance and Power Consumption.** Do HP3 Problem 1.23.
6. (20 points) **Cost and Performance.**

   In the calculation of cost, we did not explicitly account for the *designer effort* expended in the research and development phase. For small volume chip production, the designer effort must be taken into account if the cost calculation is to be accurate. This questions asks you to explore the impact of designer effort on both the net cost price of a chip, as well as on its performance.

   Suppose that Company A uses conventional clocked technology to designs its chips. A new company, Company B, uses an emerging technology called *asynchronous,* or "clockless," design, which enables Company B to significantly shorten its design phase. In particular, Company A's clocked approach requires 10 person-years of effort

to produce a chip, while Company B's unclocked approach requires only 5 person-years of effort to produce a functionally identical chip.[1] However, since asynchronous technology is not very mature yet, assume that its performance is only about 90% of that of a similar clocked design, other factors remaining the same.

(a) *Performance.* Suppose that both the companies have a deadline of Jan 1, 2006, to finish the design work on the chip. Further suppose that each company dedicates a team of 5 to the task of designing the chip, and each team starts its work as late as possible, not because they are graduate students (only kidding!), but because they would like to take advantage of newest, fastest silicon manufacturing processes. Once they choose a silicon process, the entire design phase is carried out using that process. The table below shows the dates newer silicon technologies become available, and their relative speeds.

Date:	1/1/2002	1/1/2003	1/1/2004	1/1/2005	1/1/2006
Tech:	0.15μm	0.13μm	0.11μm	90nm	65nm
Speed:	0.7	1	1.3	1.7	2.2

Question: Which company's chip will be faster, and by how much? (10 points)

(b) *Cost.* Assume that the manufacturing cost of each chip is \$50, for both the companies, without taking into account the design effort. Each company hopes to sell 25,000 such chips. Assume that each designer is paid an annual salary and benefits totalling \$100,000. Suppose each company wants to increase the price of their chips by an amount that allows them to fully recover the costs of maintaining its design team (but not more).

Question: At what price will each company need to price their chip? (10 points)

[1]Note that 10 person-years means 1 designer will take 10 years to complete the project. Assume that doubling the workforce will halve the time taken.