

# COE 308 – Computer Architecture

## Term 052 – Spring 2006

### Assignment 1: Computer Abstractions and Technology

Due Saturday, February 25, 2006

1. (6 pts) Find the word or phrase from the list below that best matches the description in the following questions. Each answer should be used only once.

<b>Control</b>	<b>Transistor</b>
<b>Wafer</b>	<b>Assembler</b>
<b>Embedded system</b>	<b>Cache</b>
<b>Digital Video Disk (DVD)</b>	<b>DRAM</b>
<b>Instruction set architecture</b>	<b>Abstraction</b>
<b>Server</b>	<b>Yield</b>
<b>Datapath</b>	<b>Defect</b>

- a) Approach to the design of hardware or software. The system consists of layers, with each lower layer hiding details from the level above.
  - b) Computer inside another device used for running one predetermined application or collection of software.
  - c) Interface that the hardware provides to the low-level software.
  - d) Integrated circuit commonly used to construct main memory.
  - e) Microscopic flaw in a wafer.
  - f) Percentage of good dies from the total number of dies on the wafer.
  - g) Small, fast memory that acts as a buffer for the main memory.
  - h) Thin disk sliced from a silicon crystal ingot, which will be later divided into dies.
  - i) Component of the processor that performs arithmetic operations.
  - j) Component of the processor that tells the datapath what to do according to the instructions of the program.
  - k) On/Off switch controlled by electricity.
  - l) Computer used for running large programs for multiple users often simultaneously and typically accessed only by a network.
  - m) Optical storage medium with a storage capacity of more than 4.7 GB.
  - n) Program that converts symbolic versions of instructions into their binary formats.
2. (2 pts) In a magnetic disk, the disks containing the data are constantly rotating. On average, it should take half a revolution for the desired data on the disk to spin under the read/write head. Assuming that the disk is rotating at 5400 RPM, what is the average time for the data to rotate under the disk head? What is the average time if the disk is spinning at 7200 RPM?

3. (2 pts) A DVD drive works in the Constant Linear Velocity (CLV) mode. The read head must interact with the concentric circles at a constant rate, whether it is accessing data from the inner or outermost portions of the disc. This is affected by varying the rotation speed of the disc, from 1600 RPM at the center to 570 RPM at the outside. Assume that the DVD drive reads 1.35 MB of data per second, how many bytes can the outside circle store? How many bytes can the inner circle store?
4. (5 pts) The cost of an integrated circuit can be expressed in three simple equations:

$$\text{Cost per die} = \frac{\text{Cost per wafer}}{\text{Dies per wafer} \times \text{yield}}$$

$$\text{Dies per wafer} = \frac{\text{Wafer area}}{\text{Die area}}$$

$$\text{Yield} = \frac{1}{(1 + (\text{Defects per area} \times \text{Die area}/2))^2}$$

The following figure shows key statistics for DRAM production over 12 years:

Year	Capacity	Die area	Wafer diameter	Yield
1980	64K bits	0.16 cm <sup>2</sup>	5 inches	48%
1983	256K bits	0.24 cm <sup>2</sup>	5 inches	46%
1985	1024K bits	0.42 cm <sup>2</sup>	6 inches	45%
1989	4096K bits	0.65 cm <sup>2</sup>	6 inches	43%
1992	16384K bits	0.97 cm <sup>2</sup>	8 inches	48%

- a) (1 pt) Given the increase in die area of DRAMs, what parameter must improve to maintain yield?
- b) (2 pts) Derive a formula for the improving parameter found in (a) from the other parameters.
- c) (2 pts) Using the formula in the answer to (b), what is the calculated improvement in that parameter between 1980 and 1992?
5. (3 pts) Assume you are in a company that will market a certain IC chip. The fixed costs, including R&D, fabrication and equipments, and so on, add up to \$500,000. The cost per wafer is \$6000, and each wafer can be diced into 1500 dies. The die yield is 50%. Finally, the dies are packaged and tested, with a cost of \$10 per chip. The test yield is 90%; only those that pass the test will be sold to customers. If the retail price is 40% more than the cost, at least how many chips have to be sold to break even?
6. (2 pts) Sometimes software optimization can dramatically improve the performance of a computer system. Assume that a CPU can perform a multiplication operation in 10ns, and a subtraction operation in 1ns. How long will it take for the CPU to calculate the result of  $d = a \times b - a \times c$ ? How do you optimize the equation so that it will take less time, and what is the optimized time?