COSC 3330/6308—COMPUTER ARCHITECTURE
Fall 2012

THIRD PROBLEM SET
Due Wednesday, November 28 IN CLASS

1. You are to design a TLB for a virtual memory system with 64-bit addresses and 4-kilobyte pages. It should have with 64 entries with each entry mapping one virtual page into one physical page. You are to consider two possible TLB organizations, namely one using direct mapping and another using two-way associativity.

   a) What would be the minimum sizes *in bits* of the entry tags for each of these two cache organizations? (2×5 easy points)

   b) Describe *at the bit level* how the hardware should access each of these caches? (2×10 points)

   c) How will each of the two caches handle *collisions*? (2 + 8 points for a detailed solution)

   d) Measurements on the direct mapping cache indicate that 80 percent of the misses are compulsory misses, 19 percent of them are capacity misses and the remaining misses are all associativity misses. What conclusions can you draw? (5 points)

2. A given make of disks has a failure rate of 5 percent per year.

   a) What is the mean time to failure of these disks? (5 easy point)

   b) Assuming that all data are mirrored on two disks, and that it takes twelve hours to replace a failed disk and restore its contents, what is the probability that a single disk failure will lead to a data loss? (5 points) (***Hint:** consider the probability of a second failure while the failed disk gets replaced.*)

   c) Consider a disk farm consisting of 100 pairs of mirrored disks for a total of 200 disks. What would be the probability of a data loss over a period of five years? (10 points)

3. A file server crashes on the average once every ten days.

   a) What is the mean time between failures of this server? (5 points)

   b) What is the maximum mean time to repair that we can tolerate if we want to achieve an average availability of 99.5 percent? (5 points)

4. A RAID level 6 array has eight data blocks (b_0 to b_7) and two parity blocks p and q per stripe.

   a) How much of the total disk space is used by data blocks? (5 easy points)

   b) What is the best way to update block b_5 and its two parity blocks? (10 points)

5. A task is distributed along 128 processors but the maximum observed speedup is only 50. People suspect that this low figure is due to a single processor. What is the share of the workload that is executed by that processor? (5 points)

6. People in your research group are unhappy with the speed of the computer they use to run a huge program. Somebody suggests upgrading the CPU of the computer. What do we need to know before deciding to do so? (5 points)