Computer Architecture Homework #7
Due: November 20, 2009 (Friday 5 PM)

1. Suppose we had a block transfer from an I/O device to memory. The block consists of 2048 words and one word can be transferred to/from memory at a time. For each of the following, indicate the number of interrupts needed to transfer a block using:

a) DMA (direct-memory access) 1

.75 b) interrupt-driven I/O 2048

c) programmed-I/O 0

.5 2. Give an example where programmed-I/O might be used. Embedded processor that does not have anything else to do

.5 3. Explain the difference between programmed I/O and interrupt-driven I/O. Pgmmed I/O wastes CPU time while it polls I/O status, but interrupt-driven I/O can run another pgm.

.5 4. Explain the difference between interrupt-driven I/O and DMA. – DMA module moves block of data between Memory + I/O device before interrupting

.5 5. Assume special I/O instructions are used to fill I/O-controller registers. Why can't a user program use these instructions to communicate with the I/O device directly and "by-pass" the operating system's protection checking? I/O instr. would be privileged so only the O.S can execute them

.5 6. Assume that memory-mapped I/O is used. Since Load and Store instructions are used to communicate with the I/O-controller registers, why can't a user program communicate with the I/O device directly and "by-pass" the operating system's protection checking? The memory addrs of the I/O controller regs would be outside of the user pgm addr. space.

7. Suppose that you are setting up a computer system as a database server for your company. You have enough money to buy a 4 disk RAID array which can configured as either:

- RAID 0 (nonredundant),
- RAID 1 (mirrored)
- RAID 3 (bit-interleaved with a parity disk)
- RAID 5 (block-level with distributed parity blocks)

How would you configure the RAID array? (Justify you answer)

.75 RAID 1 with large strips will provide

+ multiple concurrent I/Os
+ protection from at least one disk failure and maybe two
- total storage capacity of 2 disks

RAID 5 will provide

+ Multiple concurrent I/Os
+ Protection from one disk failure
+ total storage capacity of 3 disks.

8. Assume an 8-disk RAID array. Each disk has 100 MB/sec data transfer rate.

a) Fill in the following table to compare the following RAID levels **assuming no disk failures.**

RAID Level	Data transfer rate for single, large I/O request	Number of concurrent, small READ requests	Number of concurrent, small WRITE requests
0 (large strip)	100 MB/sec	8	8
0 (bit-wise interleaving)	800 MB/sec	1	1
1 large strip / bitwise	100 MB/sec / 400 MB/sec	8 / 2	4 / 1
2	400 MB/sec	1	1
3	700 MB/sec	1	1
4	100 MB/sec	7	1
5	100 MB/sec	8	4

b) Fill in the following table to compare the following RAID levels **assuming one disk failure.**

RAID Level	Data transfer rate for single, large I/O request	Number of concurrent, small READ requests	Number of concurrent, small WRITE requests
0 (large strip)	—	—	—
0 (bit-wise interleaving)	—	—	—
1 large / bitwise	100 MB/sec / 400 MB/sec	7 / 1	4 / 1
2 failed data	400 MB/sec	1	1
3	700 MB/sec	1	1
4 failed parity disk / failed data disk	100 MB/sec / 100 MB/sec	7 / 6 + 1	7 / 1
5	100 MB/sec	7	4

$\lceil \log_2 \#\text{Data} \rceil + 1$

$\log_2 4 + 1$

$2 + 1$