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| Instructor | ***Papademas*** | Due Date |  |

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| Part | **1** | **2** | **3** | **4** | Total |
| *Maximum Points* | **25** points | **25** points | **25** points | **25** points | **100**G101010 pointsG |
| ***Your Score*** |  |  |  |  |  |

**Textbook Reading Assignment**

Thoroughly read Chapter(s) 7 in your Computer Architecture and Organization textbook.

**Part 1 Glossary Terms - Input / Output and Storage Systems**

Define, in detail, each of these glossary terms from the realm of computer architecture and computer topics, in general. If applicable, use examples to support your definitions. Consult your notes

or course textbook(s) as references or the Internet by visiting Web sites such as:

[**http://www.bing.com**](http://www.bing.com) or [**http://www.webopedia.com**](http://www.webopedia.com/)

**(a) Amdahl’s Law**

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| Amdahl’s law describes the overall speedup of a system in terms of both the speedup of a particular component (e.g., a new CPU) and how much that component is used by the rest of the system in a quantifiable way. |

**(b) Data Compression**

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| Data compression, in the context of I/O architecture, refers to methods to compress data both for storage and transmission. |

**(c) I / O Architectures**

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| I/O architectures refer to the subsystems of components that moves coded data between external devices and a host system (a CPU and main memory). These include various control methods (programmed I/O, interrupt driven I/O, memory mapped I/O, direct memory access and channel attached I/O) as well as data transmission modes (parallel vs. serial). |

**(d) RAID**

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| RAID, or “Redundant Arrays of Inexpensive Disks”, refers to a redundancy schema for enterprise storage systems (e.g., an IBM mainframe) and consists of up to seven levels of redundancy in case of disk failure (via power surge, disk decomposition, etc.). Redundancy systems for enterprise storage systems is extremely important. |

**(e) Transmission Modes**

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| Data transmission modes for transferring data to and from a host system and an external component include both serial transmissions (bit by bit) and parallel transmission (byte by byte). |

**Part 2 Exercises - Input / Output and Storage Systems**

For each of the following, enter True or False.

\_\_\_\_\_ **(1)** A standard monitor is the only output device that presents results to the user.

**TRUE (2)** The simplest way for a CPU to communicate with an I / O device is through polled I / O .

**FALSE (3)** Channel I / O is a type of non - isolated I / O because the systems are equipped with separate I / O buses.

**TRUE (4)** Two types of transmission modes are serial and parallel transmission modes.

**FALSE (5)** Rewritable optical media replace the dye and reflective coating layers of a CD - R disk with a non - metallic alloy.

**TRUE (6)** The storage systems that are not protected by RAID are known as just a bunch of disks ( JBOD ) .

**TRUE (7)** RAID Level 1 , or RAID - 1 , is also known as disk mirroring.

**TRUE (8)** A hologram is a three - dimensional image rendered by the manipulation of laser beams.

**FALSE (9)** Memristor memories are a type of volatile RAM .

**TRUE (10)** The I / O modules take care of data movement between main memory and a particular device interface.

**Part 3 Exercises - Input / Output and Storage Systems**

**(1)** **( Amdahl’s Law )**

Amdahl’s Law is given by the equation:

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| *S* = | 1 |
| ( 1 − *f* ) + *f*  / *k* |

where

*S* is the overall speedup

*f* is the fraction of work performed by a faster component

*k* is the speedup of the faster component.

Calculate the overall speedup of a system that spends *f* = 65 % of its time on I / O with a disk upgrade that provides for 50 % greater throughput ( with *k* = 1.5 ) .

Show your calculations.  
  
 **Answer = 27.7% total system speedup (S = 1.276595745)**

**Work:**

**S = 1 / ((1 - .65) + (.65 / 1.5)) = 1.276595745**

**(2)** **( Amdahl’s Law )**

Calculate the overall speedup of a system that spends 40 % of its time in calculations with a processor upgrade that provides for 100 % greater throughput.

**Answer = 25% speedup (S = 1.25)**

**Work:**

**S = 1 / ((1 - .40) + (.40 / 2)) = 1.25**

**(3)** **( Amdahl’s Law )**

Suppose that you are designing a game system that responds to players' pressing buttons and toggling joysticks. The prototype system is failing to react in time to these input events, causing noticeable annoyance to the gamers. You have calculated that you need to improve overall system performance by 50 % . This is to say that the entire system needs to be 50 % faster than it is now. You know that these I / O events account for 75 % of the system workload. You figure that a new I / O interface card should do the trick. If the system's existing I / O card runs at 10 kHz ( pulses per second ) , what is the speed of the I / O card that you need to order from the supplier?

**Answer: 18 kHz (k = 1.8)**

**Work:**

**1.5 = 1 / ( ( 1 - .75 ) + ( .75 / k ) )**

**k = 1.8**

**10kHz x 1.8 = 18kHz**

**(4)** **( Amdahl’s Law )**

Your friend has just bought a new personal computer. She tells you that her new system runs at 1GHz , which makes it over three times faster than her old 300 MHz system. What would you tell her? ( Hint: Consider how Amdahl's Law applies. )

**I would tell her that the overall performance increase would depend on the fraction of the work performed by I/O events.**

**(5)** **( I / O Architectures )**

Name the four types of I / O architectures. Where are each of these typically used and why are they used there?

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| **Five architectures are mentioned in the Null et al.:**   1. Programmed I/O – this is typically used in ATMs and other embedded systems, because it is contantly polling a control register, the CPU is constantly in a “busy / wait” loop, and can’t do any other useful work, therefore it is more useful in embedded systems. 2. Interrupt-Driven I/o – this is typically used in operating systems on a PC, as it is the external device that tells the CPU (via interrupt) that it has data ready to send, which frees the CPU up to do other work as it is not constantly polling the device for new data. 3. Memory-Mapped I/0 – simplified system design when RAM or VRAM is available, devices share same address space as main memory, making read / write work in the same way as memory access does. Not mentioned in the book but I imagine that this architecture would be suitable in any system with plentiful RAM or VRAM (e.g. a personal computer). 4. Direct memory access – DMA uses a dedicated chip with instructions for transferring I/O data, which offloads work from the CPU and frees up the CPu for additional processing. 5. Channel I/O – an I/O channel is an intelligent form of a DMA interface that have their own CPUs called I/O processors. Essentially this architecture allows control of multiple devices through their own controllers, and is used in large mainframe systems with many disks. |

**Part 4 Exercises - Input / Output and Storage Systems**

Write a complete answer for each of these.

**(1) ( Seek Time, Rotational Delay, Transfer Time )**

Define the terms seek time, rotational delay and transfer time. Explain their relationship.

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| Seek time is the time it takes for a disk arm to position itself over the required track on a disk, rotational delay is the time it takes for the required sector to position itself under a head, and transfer time is the sum of the time it takes to seek, rotate and read data on a disk. |

**(2) ( Random Access Device )**

Why do you think the term random access device is something of a misnomer for disk drives?

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| Because each unit of storage on a disk has a unique address that can be directly access independently of the sectors around it, disk drives are said to have “random access”, though perhaps “direct access,” as mentioned in Null et al., is a better term. |

**(3) ( Disk Directories )**

Why do differing systems place disk directories in different track locations on the disk? What are the advantages of using each location that you cited?

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| The answer to this question was not immediately apparent in section 7.6 in Null et Al., however the fact that data is often denser at the center of a disk, less dense at the outer reaches of the disk, is made clear. I am sure this has something to do with cost / benefit analysis of access time and storage capacity made by manufacturers. |

**(4) ( Hard Disk Capacity )**

Suppose a disk drive has the following characteristics:

• 4 surfaces

• 1024 tracks per surface

• 128 sectors per track

• 512 bytes / sector

• track - to - track seek time of 5 milliseconds

• rotational speed of 5000 RPM

(a) What is the capacity of the drive? Hint: use this product.

? surfaces × ? tracks per surface × ? sectors per track × ? bytes / sector

Show your calculations.  
  
 **Answer: 268 megabytes (268435456 bytes)**

**Work: 4 x 1024 x 128 x 512 = 268435456**

(b) What is the access time? Hint: use this expression.

Rotational Delay = [ ( ? secs / ? rpm) × ( ? ms / second ) ] / 2 + ? ms seek time

Show your calculations.

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| Expression unclear, unclear what is meant by ? secs and ? ms |

**(5) ( Hard Disk Capacity )**

Suppose a disk drive has the following characteristics:

• 5 surfaces

• 1024 tracks per surface

• 256 sectors per track

• 512 bytes / sector

• track - to - track seek time of 8 milliseconds

• rotational speed of 7500 rpm

(a) What is the capacity of the drive? Show your calculations.

**Answer: 671 megabytes (671088640 bytes)**

**Work: 5 x 1024 x 256 x 512 = 671088640**

(b) What is the access time? Show your calculations.

Expression unclear, unclear what is meant by ? secs and ? ms

(c) Is this disk faster than the one described in the above question? Explain.

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| Expression unclear, unclear what is meant by ? secs and ? ms |