

CS3360: Homework #1

Due on Friday Feb, 3rd @ 11:55 pm (Canvas submission)

PLEASE READ: You may discuss this problem set with other students as long as you do not share/verify answers. However, you must also write the names of other students you discussed any problem with. You must *write up your answers on your own showing your work*. Each problem has a different weight. Please state any assumptions you are making in solving a given problem. Late assignments will not be accepted with prior arrangements. By submitting this assignment, you acknowledge that you have read the course syllabus and abiding to the copyright (e.g., no posting) and Honor Code (e.g., not using note sharing sites such as Chegg, OneClass, CourseHero, etc.) requirements.

Problem 1

Consider the following two alternatives in which keyboard interrupts can be handled.

Scenario 1: Each character typed causes an interrupt service routine to execute for 0.01 millisecond (to copy the character typed from the keyboard to memory). You can assume that a computer user is typing at an average rate of 200 characters per minute.

Scenario 2: Every 50 milliseconds an interrupt service routine executes for 0.1 milliseconds and copies any buffered data from the keyboard to memory.

Answer the following questions:

- (a) What percentage of the CPU's utilization would be used in handling interrupts in each scenario? **[4 pts]**
- (b) Give one advantage of scenario 1 over scenario 2. **[2 pts]**
- (c) Give one advantage of scenario 2 over scenario 1. **[2 pts]**

Problem 2

A network card in a computer is connected to a switch with a link capable of delivering 10 Mbps (Megabits per second). The network card receives an average of 10 packets every 50 milliseconds from a streaming connection. Assume that each packet is 1000 Bytes. Answer the following questions:

- (a) What is the average throughput achieved by the streaming connection? Assume no packets are dropped. **[2 pts]**
- (b) What is the utilization of the network link? **[2 pts]**

Problem 3

Consider a program that performs the following steps repeatedly:

1. Use the CPU for 4 milliseconds.
2. Issue in I/O to disk for 14 milliseconds.
3. Use the CPU for 10 milliseconds.

4. Issue an I/O to the network for 18 milliseconds.

Assume that each step depends on data obtained from the previous step (e.g., step 3 cannot start before step 2 is completed). Answer the following questions:

- (a) Draw 3 time-line diagrams (time on the x-axis and utilization on the y-axis) that illustrate the utilizations of the CPU, disk, and network over the execution of two iterations of the program above. **[3 pts]**
- (b) What are the average utilizations of the CPU, disk and network over these two iterations? **[3 pts]**
- (c & d) Assume that there are two independent processes of the program above running in a multiprogramming system (i.e., when a process blocks for I/O, another process can get the CPU), answer parts (a) and (b) for this case showing which part belongs to which process. You can ignore the time spent in context switching. **[6 pts]**

Problem 4

Consider 5 processes, A, B, C, D and E, arriving to a system with a single CPU according to the table below. Each process has an arrival time and service time (time needed on the CPU). Assume the CPU services these processes in a First-in-First-Out (FIFO) fashion. Also assume that the CPU is used 100% of the time during the service time of any process.

	Arrival Time	Duration (service time needed)
Process A	1	3sec
Process B	0	2 sec
Process C	7	6 sec
Process D	8	1 sec
Process E	10	4 sec

Answer the following questions:

- (a) How long would it take until all the processes are done? **[2 pts]**
- (b) Draw the utilization of the CPU over time? **[2 pts]**
- (c) What is the average utilization of the CPU? **[2 pts]**
- (d) What is the overall system throughput in processes done per second? **[2 pts]**
- (e) What is the average turnaround time for all processes? **[2 pts]**

Problem 5

- (a) What is the overhead of context switching if a short-term scheduler takes 1 millisecond to decide on the next process to execute on the CPU and it gives each process 10 milliseconds of execution time? Assume the CPU never goes idle. **[2 pts]**
- (b) Give two conditions upon which a context switch must occur in a multiprogramming system? **[2 pts]**

Problem 6

Suppose that the Mean Time Between Failures (MTBF) of single hard disk is 100,000 hours. Also assume that disk failures are independent of each other. Answer the following questions:

- (a) What is the MTBF of a file system (i.e., a failure here is when any disk fails) composed of 20 disks? **[2 pts]**
- (b) What is the MTBF of a data center (i.e., a failure here is when any disk fails) composed of 20,000 disks? **[2 pts]**
- (c) If your answer for part (b) is not acceptable for the operation of the data center, what can be done? **[2 pts]**

Problem 7

Consider two learning management systems (let's denote them by A and B – such as Canvas or TRACS). Both systems go down for maintenance for 2 hours every month. System A goes down once per month for 2 hours, whereas system B goes down 6 times per month for 20 minutes each time. Answer the following questions:

- (a) What is the availability of System A? **[2 pts]**
- (b) What is the availability of System B? **[2 pts]**
- (c) What is the MTBF of System A? **[2 pts]**
- (d) What is the MTBF of System B? **[2 pts]**